PBS Modelling 1: User's Guide

Jon T. Schnute, Alex Couture-Beil, and Rowan Haigh

Fisheries and Oceans Canada
Science Branch, Pacific Region
Pacific Biological Station
3190 Hammond Bay Road
Nanaimo, British Columbia
V9T 6N7

2006

Canadian Technical Report of Fisheries and Aquatic Sciences 2674

Fisheries and Oceans Canada | Pêches et Océans Canada

Canada

Canadian Technical Report of
Fisheries and Aquatic Sciences

Technical reports contain scientific and technical information that contributes to existing knowledge but which is not normally appropriate for primary literature. Technical reports are directed primarily toward a worldwide audience and have an international distribution. No restriction is placed on subject matter and the series reflects the broad interests and policies of the Department of Fisheries and Oceans, namely, fisheries and aquatic sciences.

Technical reports may be cited as full publications. The correct citation appears above the abstract of each report. Each report is abstracted in *Aquatic Sciences and Fisheries Abstracts* and indexed in the Department's annual index to scientific and technical publications.

Numbers 1 - 456 in this series were issued as Technical Reports of the Fisheries Research Board of Canada. Numbers 457 - 714 were issued as Department of the Environment, Fisheries and Marine Service Technical Reports. The current series name was changed with report number 925.

Technical reports are produced regionally but are numbered nationally. Requests for individual reports will be filled by the issuing establishment listed on the front cover and title page. Out-of-stock reports will be supplied for a fee by commercial agents.

Rapport technique canadien des
sciences halieutiques et aquatiques

Les rapports techniques contiennent des renseignements scientifiques et techniques qui constituent une contribution aux connaissances actuelles, mais que ne sont pas normalement appropriés pour la publication dans un journal scientifique. Les rapports techniques sont destinés essentiellement à un public international et ils sont distribués à cet échelon. Il n'y a aucune restriction quant au sujet; de fait, la série reflète la vaste gamme des intérêts et des politiques du ministère des Pêches et des Océans, c'est-à-dire les scences halieutiques et aquatiques.

Les rapports techniques peuvent être cités comme des publications complètes. Le titre exact paraît au-dessus du résumé de chaque rapport. Les rapports techniques sont résumés dans la revue *Résumés des sciences aquatiques et halieutiques*, et ils sont classés dans l'index annual des publications scientifiques et techniques du Ministère.

Les numéros 1 à 456 de cette série ont été publiés à titre de rapports techniques de l'Office des recherches sur les pêcheries du Canada. Les numéros 457 à 714 sont parus à titre de rapports techniques de la Direction générale de la recherche et du développement, Service des pêches et de la mer, ministère de l'Environnement. Les numéros 715 à 924 ont été publiés à titre de rapports techniques du Service des pêches et de la mer, ministère des Pêches et de l'Environnement. Le nom actuel de la série a été établi lors de la parution du numéro 925.

Les rapports techniques sont produits à l'échelon regional, mais numérotés à l'échelon national. Les demandes de rapports seront satisfaites par l'établissement auteur dont le nom figure sur la couverture et la page du titre. Les rapports épuisés seront fournis contre rétribution par des agents commerciaux.

2007-01004/

Canadian Technical Report of

Fisheries and Aquatic Sciences 2674

2006

PBS Modelling 1: User's Guide

by

Jon T. Schnute, Alex Couture-Beil, and Rowan Haigh

Fisheries and Oceans Canada

Science Branch, Pacific Region

Pacific Biological Station

3190 Hammond Bay Road

Nanaimo, British Columbia

V9T 6N7

CANADA

© Her Majesty the Queen in Right of Canada, 2006

Cat. No. Fs97-6/2674E ISSN 0706-6457

9 8 7 6 5 4 3 2 1 (First printing – December, 2006)

Correct citation for this publication:

Schnute, J.T., Couture-Beil, A., and Haigh, R. 2006. PBS Modelling 1: user's guide. Can. Tech. Rep. Fish. Aquat. Sci. 2674: viii + 114 p.

TABLE OF CONTENTS

Abstract v
Résumé v
Preface vi
1. Introduction 1
2. GUI tools for model exploration 3
  2.1. Example: Lissajous curves 4
  2.2. Window description file 6
  2.3. Window support functions 8
  2.4. Internal data for windows 11
3. Functions for data exchange 12
4. Functions for graphics and analysis 14
  4.1. Graphics utilities 14
  4.2. Data management 15
  4.3. Function minimization and maximum likelihood 15
  4.4. Handy utilities 16
5. Examples 17
  5.1. Random variables 18
    5.1.1. `RanVars` – Random variables 18
    5.1.2. `RanProp` – Random proportions 19
    5.1.3. `SineNorm` – Sine normal 20
    5.1.4. `CalcVor` – Calculate Voronoi tessellations 21
  5.2. Statistical analyses 22
    5.2.1. `LinReg` – Linear regression 22
    5.2.2. `MarkRec` – Mark-recovery 23
    5.2.3. `CCA` – Catch-curve analysis 24
  5.3. Other applications 25
    5.3.1. `FishRes` – Fishery reserve 25
    5.3.2. `FishTows` – Fishery tows 26
References 27
Appendix A. Widget descriptions 29
  Button 29
  Check 29
  Data 30
  Entry 32
  Grid 33
  History 34
  Label 35
  Matrix 35
  Menu 37
  MenuItem 37
  Null 38
  Object 38
  Radio 40

Slide 41
SlidePlus 41
Text 42
Vector 43
Window 45
Appendix B. Building `PBSmodelling` and other packages 46
B.1. Installing required software 46
B.2. Building `PBSmodelling` 48
B.3. Creating a new R package 49
B.4. Embedding C code 52
Appendix C. *PBS Modelling* functions and data 56
C.1. Objects in *PBS Modelling* 56
C.2. Function dependencies 60
C.3. *PBS Modelling* manual 64

LIST OF TABLES

Table 1. Lissajous project files 4
Table 2. R source code with GUI definition strings 9
Table 3. Data file in PBS format 12
Table B1. C representations for R data types 52
Table B2. `.C()` example in `PBStry` 53
Table B3. `.Call()` example adapted from `PBStry` 54

LIST OF FIGURES

Figure 1. Tangled relationships 2
Figure 2. GUI organization 2
Figure 3. Lissajous GUI 5
Figure 4. Lissajous graph 5
Figure 5. `RanVars` GUI and density plot 18
Figure 6. `RanProp` GUI and pairs plot for Dirichlet 19
Figure 7. `SineNorm` GUI and plot 20
Figure 8. `CalcVor` GUI and tessellation plot 21
Figure 9. `LinReg` GUI and regression plot 22
Figure 10. `MarkRec` GUI and density plots 23
Figure 11. `CCA` GUI and parameter pairs plot 24
Figure 12. `FishRes` GUI and population time series 25
Figure 13. `FishTows` GUI and simulated tow tracks 26

ABSTRACT

Schnute, J.T., Couture-Beil, A., and Haigh, R. 2006. PBS Modelling 1: user's guide. Can. Tech. Rep. Fish. Aquat. Sci. 2674: viii + 114 p.

This report describes the R package *PBS Modelling*, which contains software to facilitate the design, testing, and operation of computer models. The initials *PBS* refer to the Pacific Biological Station, a major fisheries laboratory on Canada's Pacific coast in Nanaimo, British Columbia. Initially designed for fisheries scientists, this package has broad potential application in many scientific fields. *PBS Modelling* focuses particularly on tools that make it easy to construct and edit a customized graphical user interface (GUI) appropriate for a particular problem. Although our package depends heavily on the R interface to Tcl/Tk, a user does not need to know Tcl/Tk. In addition to GUI design tools, *PBS Modelling* provides utilities to support data exchange among model components, conduct specialized statistical analyses, and produce graphs useful in fisheries modelling and data analysis. Examples implement classical ideas from fishery literature, as well as our own published papers. The examples also provide templates for designing customized analyses using other R libraries, such as *PBS Mapping*, *odesolve*, and *BRugs*. Users interested in building new packages can use *PBS Modelling* and a simpler enclosed package *PBS Try* as prototypes. An appendix describes this process completely, including the use of C code for efficient calculation.

RÉSUMÉ

Schnute, J.T., Couture-Beil, A., and Haigh, R. 2006. PBS Modelling 1 : guide de l'utilisateur. Can. Tech. Rep. Fish. Aquat. Sci. 2674: viii + 114 p.

Le présent rapport décrit la trousse R *PBS Modelling* qui contient des logiciels permettant de rendre plus aisés la conception, les essais et l'utilisation des modèles numériques. L'acronyme PBS fait référence à la *Pacific Biological Station* (Station biologique du Pacifique), un grand laboratoire axé sur l'étude des pêches sur la côte canadienne du Pacifique à Nanaimo, en Colombie-Britannique. Initialement conçue pour les chercheurs travaillant sur les pêches, cette trousse peut être utilisée dans de nombreux domaines scientifiques. *PBS Modelling* contient principalement des outils qui facilitent la construction et la modification d'une interface graphique (GUI) sur mesure, adaptée à un problème particulier. Bien que cette trousse s'appuie sur l'interface R pour Tcl/Tk, ses utilisateurs n'ont pas besoin de connaître le langage Tcl/Tk. En plus d'offrir des outils de conception de GUI, *PBS Modelling* propose des logiciels permettant d'échanger plus facilement des données entre les composants de divers modèles, d'effectuer des analyses statistiques spécialisées et de produire des graphiques utiles pour la modélisation et l'analyse des données concernant les pêches. Les exemples fournis mettent en application des idées classiques glanées dans les articles publiés sur les pêches ainsi que dans nos propres articles publiés. Ces exemples fournissent également des modèles dont l'utilisateur peut s'inspirer pour concevoir des protocoles d'analyse sur mesure à l'aide d'autres librairies R telles que *PBS Mapping*, *odesolve* et *BRugs*. Les utilisateurs qui désirent construire de nouvelles trousses peuvent utiliser *PBS Modelling* et la trousse simple *PBS Try* comme prototypes. Ce procédé est décrit de manière détaillée en annexe, y compris l'utilisation du langage C pour les calculs.

Preface

After working with fishery models for more than 30 years, I've used a great variety of computer software and hardware. Currently, the free distribution of R (R Development Core Team 2006a) provides an excellent platform for software development in an environment designed to support multiple computers and operating systems. Furthermore, an associated network of contributed libraries on the Comprehensive R Archive Network (CRAN: http://cran.r-project.org/) gives access to a wealth of algorithms from many users in various fields. This disciplined system allows users, like the authors of this package, to distribute software that extends the utility of R in new directions.

Previously I've used software in Basic (Schnute 1982), Fortran (Mittertreiner and Schnute 1985), Pascal, C, and C++ to implement ideas in published papers. Usually this software goes stale in time, due to minimal documentation, changing operating systems, the lack of portable libraries, and many other factors. Because R includes a rich library of statistical software that operates on multiple platforms, my colleagues and I can now distribute software that actually works when other people try it. The user community includes us, because we often find that we can't remember how to operate our own software after a few weeks or months, let alone years. Although writing a good R package requires considerable effort, the result often pays off in portability, communication, and long term usage.

PBS Modelling tries to accomplish several goals. First, it anticipates the need for model exploration with a graphical user interface, a so-called GUI (pronounced gooey). We make this easy by encapsulating key features of the Tcl/Tk library into convenient tools fully documented here. A user need not learn Tcl/Tk to use this package. Everything required appears in Appendix A. You might want to start by running the function `testWidgets()`. Co-author Rowan Haigh likes the subtitle: "modelling the world with gooey substances."

Second, we want to demonstrate interesting analyses related to our work in fishery management and other fields. The function `runExamples()` illustrates some of these, as described further in Section 5. The code for all of them appears in the R library directory `PBSmodelling\Examples`. We demonstrate the power of other R libraries, such as `BRugs` (to perform Bayesian posterior sample with the application `WinBUGS`), `odesolve` (to solve differential equations numerically), and `PBSmapping` (to draw maps and perform spatial analyses).

Third, *PBS Modelling* serves as a prototype for building a new R package, as summarized in Appendix B. We illustrate two methods of calling C code (`.C` and `.Call`), and discuss many other technical issues encountered while building this library.

Finally, to use R effectively, we've found it convenient to devise a number of "helper" functions that facilitate data exchange, graphics, function minimization, and other analyses. We include these here for the benefit of our users, who may choose to ignore them. We hope that *PBS Modelling* inspires interest in interactive models that demonstrate applications in many fields.

As with our earlier package *PBS Mapping*, Rowan and I employed a bright student who could learn quickly and implement creative ideas. Dr. Jim Uhl (Computing Science) and Dr. Lev Idels (Mathematics), both from Malaspina University-College (MUC) here in Nanaimo, drew my attention to the student Alex Couture-Beil, who has strong credentials in both fields. Rowan and I gave him a few initial specifications, and he quickly got ahead of us by extending our ideas in new and useful directions. *PBS Modelling* version 1 represents the result of an evolutionary process, as we experimented with design concepts that would support our modelling goals. Users familiar with the earlier version 0.60 (posted on CRAN in August, 2006) may need to revise their code slightly to make it work with this version.

Since 1998, I have maintained a formal relationship with the Computing Science Department at MUC, where I find kindred spirits in developing projects like this one. I particularly want to thank Dr. Jim Uhl for his suggestions and support on this project. Conversations with Dr. Peter Walsh have also stimulated my interest in the theory and application of computing science.

Fishery management depends on models with a great range of complexity, starting from some fairly simple ideas. Unfortunately from a coding perspective, "industrial strength" models can't run exclusively in R. Algorithms with high computational requirements don't run fast enough in R for practical application, due to interpretive code and other technical limitations. Examples in *PBS Modelling* often illustrate ideas at the simple end of the spectrum, although the package can certainly be used to manage external software designed to deal with greater complexity.

Scientifically, I like to work from both ends of the spectrum. The behaviour of a complex model sometimes mimics a much simpler model, and it helps to become well versed in some of the simpler cases. I appreciate the motto of Canadian storyteller and humorist Stuart McLean, who hosts a CBC radio broadcast *The Vinyl Cafe* (http://www.cbc.ca/vinylcafe/), "We may not be big, but we're small."

Jon Schnute, December 2006

This page has been left intentionally left blank for printing purposes.

1. Introduction

This report describes software to facilitate the design, testing, and operation of computer models. The package *PBS Modelling* is distributed as a freely available library for the popular statistical program R (R Development Core Team 2006a). The initials *PBS* refer to the Pacific Biological Station, a major fisheries laboratory on Canada's Pacific coast in Nanaimo, British Columbia. Previously, we produced the R library *PBS Mapping* (Schnute et al. 2004), which draws maps and performs various spatial operations. Although both packages (which can run separately or together) include examples relevant to fishery models and data analysis, they have broad potential application in many scientific fields.

Computer models allow us to speculate about reality, based on mathematical assumptions and available data. The full implications of a model usually require numerous runs with varying parameter values, data sets, and hypotheses. A customized graphical user interface (or GUI, pronounced "gooey") facilitates this exploratory process. *PBS Modelling* focuses particularly on tools that make it easy to construct and edit a GUI appropriate for a particular problem. Some users may wish to use this package only for that purpose. Other users may want to explore the examples included, which demonstrate applications of likelihood inference, Bayesian analysis, differential equations, computational geometry, and other modern technologies. In constructing these examples, we take advantage of the diversity of algorithms available in other R libraries.

In addition to GUI design tools, *PBS Modelling* provides utilities to support data exchange among model components, conduct specialized statistical analyses, and produce graphs useful in fisheries modelling and data analysis. Examples implement classical ideas from fishery literature, as well as our own published papers. The examples also provide templates for designing customized analyses using the R libraries discussed here. In part, *PBS Modelling* provides a (very incomplete) guide to the variety of analyses possible with the R framework. We anticipate many revisions of our library, as we find time to include more examples.

PBS Modelling depends heavily on Peter Dalgaard's (2001, 2002) R interface to the Tcl/Tk package (Ousterhout 1994). This combines a scripting language (Tcl) with an associated GUI toolkit (Tk). In our library, we simplify GUI design with the aid of a "window description file" that specifies the layout of all GUI components and their relationship with variables in R. We support only a subset of the possibilities available in Tcl/Tk, but we customize them in ways intended specifically for model design and exploration (Appendix A). A user of *PBS Modelling* does not need to know Tcl/Tk.

Computer models typically involve a variety of components, such as code, data, documentation, and a user interface. Figure 1 illustrates the tangled relationships that sometimes accompany computer model design. *PBS Modelling* allows the GUI to become a device for organizing components, as well as running and testing software (Figure 2). The project might involve other applications, as well as R itself. In addition to its interactive role, the GUI becomes an archival tool that reminds the developer how components, functions, and data tie together. Consequently, it facilitates the process of restarting a project at a future date, when details of the design may have been forgotten.

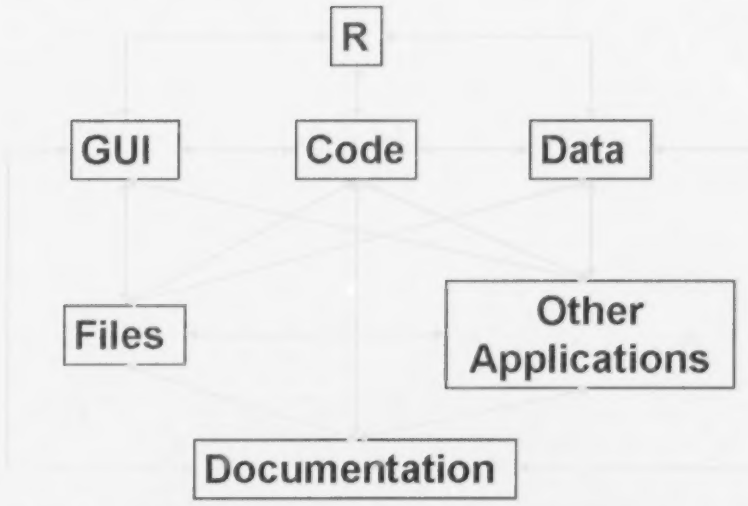


Figure 1. Tangled relationships among computer model components.

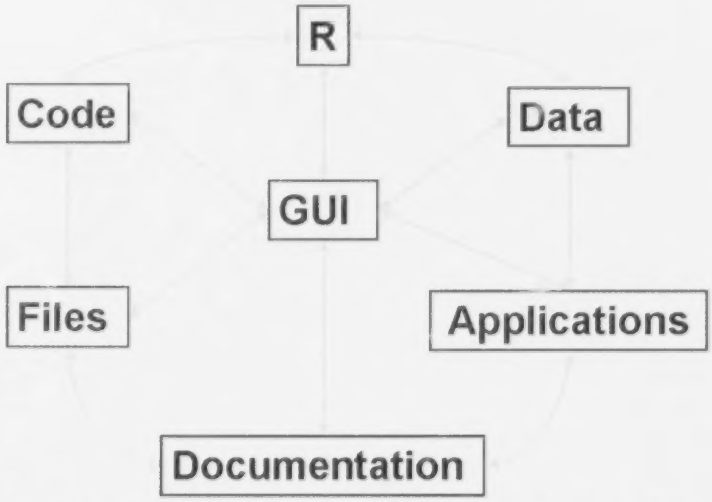


Figure 2. Computer model components organized with a graphical user interface (GUI).

In *PBS Modelling*, project design normally begins with a text file that describes the GUI. Additional files may contain code for R and other applications, which sometimes require languages other than R. For example, the R *BRugs* library (to perform Bayesian inference using Gibbs sampling) requires a file with the intended statistical model, written in the language of a separate program *WinBUGS*. In other contexts, a user might write C code to get acceptable performance from model components that require extensive computer calculations. This code might be compiled as a separate program or linked directly into a customized R package.

Section 2 of this report describes the process of designing a GUI to operate a computer model. Components can share data through text files in a specialized "PBS format" presented in

Section 3. These correspond naturally to `list` objects within R. Section 4 describes additional tools for customized graphics and data analysis. In Section 5, we highlight briefly some of the examples in our initial release, although we expect the list to expand in future versions. This guide explains the context and general purpose of all functions in *PBS Modelling*. Consult the help files for complete technical details.

Appendix A gives the complete syntax for all visual components (called *widgets*) available for writing a window description file to construct a customized GUI. Appendix B describes the process of building *PBS Modelling* in a Windows environment. A simple enclosed package *PBS Try* gives a prototype for building any R package, including the use of C code to speed calculations. Appendix C shows the help files included with the library.

To use *PBS Modelling*, run R and install the package from the R GUI (click "Packages", "Install package(s)..., select a mirror, and choose `PBSmodelling` from the list of packages). Windows users can also obtain an appropriate compressed file from the authors of this report or directly from the CRAN web site http://cran.r-project.org/.

The R GUI normally runs as a Multiple Document Interface (MDI), in which child windows like the R console and graphics screens all appear within the GUI itself and a menu item can be used to tile the sub-windows. Unfortunately, in this configuration, windows generated by Tcl/Tk sometimes disappear mysteriously when an application runs. They can be recovered by clicking the appropriate "*Tk*" icon on the taskbar. You can avoid this problem by using the Single Document Interface (SDI), in which the operating system manages all R windows (console, graphics, Tcl/Tk, etc.) independently on the desktop. Set this configuration by running the R GUI, choosing the menu items <Edit> and <GUI Preferences>, and then selecting and saving the SDI option. Alternatively, go to the master configuration file `Rconsole` in the `\etc` subdirectory of the R installation, and use a text editor to select the option `MDI = no`.

2. GUI tools for model exploration

The practical task of writing appropriate code for the R Tcl/Tk package can sometimes become daunting, particularly if the GUI window requires extensive design and change. For a restricted set of Tk components (called *widgets*), *PBS Modelling* makes it much easier to design and use GUIs for exploring models in R. A user needs to supply two key parts of a GUI-driven analysis:

- a window description file (an ordinary text file) that completely specifies the desired layout of widgets and their relationship with functions and variables in R, and
- R code that defines relevant functions, variables, and data.

This section begins with an example to illustrate the main ideas, and then gives complete details for constructing window description files that can be used to generate GUIs.

2.1. Example: Lissajous curves

A Lissajous curve (http://mathworld.wolfram.com/LissajousCurve.html), named after one of its inventors Jules-Antoine Lissajous, represents the dynamics of the system

$$x = \sin(2\pi mt), \quad y = \sin[2\pi(nt + \phi)], \tag{1}$$

where time t varies from 0 to 1. During this time interval, the variables x and y go through m and n sinusoidal oscillations, respectively. The constant ϕ, which lies between 0 and 1, represents a cycle fraction of phase shift in y relative to x. We want to design a GUI that allows us to explore this model by plotting Lissajous curves (y vs. x) for various choices of the parameters (m, n, ϕ). We also want to vary the number of time steps k and choose a plot that is either lines or points.

Table 1. Two text files associated with the "Lissajous Curve" project. The first gives a description of the GUI window used to manage the graphics. The second contains R code to draw a Lissajous curve.

File 1: `LissajousCurve.txt`

```
window title="Lissajous Curve"
vector length=4 names="m n phi k"                    \
  labels="'x cycles' 'y cycles' 'y phase' points" \
  values="2 3 0 1000"
radio name=ptype text=lines  value="l" mode=character
radio name=ptype text=points value="p" mode=character
button text=Plot function=drawLiss
```

File 2: `LissajousCurve.r`

```
drawLiss <- function() {
  getWinVal(scope="L");
  tt <- 2*pi*(0:k)/k;
  x <- sin(2*pi*m*tt); y <- sin(2*pi*(n*tt+phi));
  plot(x,y,type=ptype);
  invisible(NULL); }
```

This analysis can be accomplished with the R code and window description file shown in Table 1. Assume that these two files reside in the current working directory and that *PBS Modelling* has been installed in R. Start an R session from this directory, and type the following three lines of code in the R command window:

```
> require(PBSmodelling)
> source("LissajousCurve.r")
> createWin("LissajousCurve.txt")
```

The first line assures that *PBS Modelling* is loaded, the second defines the function `drawLiss` for drawing Lissajous curves, and the third creates a window that can be used to draw curves corresponding to any choice of parameters. Figure 3 shows the resulting GUI window interface. When the <Plot> button is clicked, the curve in Figure 4 appears in the R graphics window. This corresponds to the default parameter values:

$m = 2,\ n = 3,\ \phi = 0,\ k = 1000\,.$ (2)

The GUI allows different Lissajous figures to be drawn easily. Simply change parameter values in any of the four entry boxes, and click <Plot>.

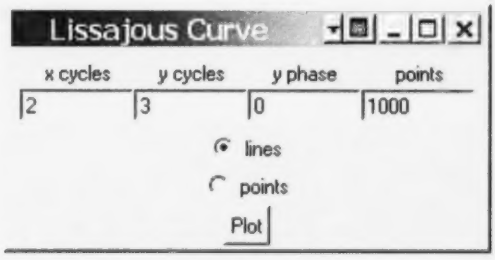


Figure 3. GUI generated by the description file `LissajousCurve.txt` in Table 1. It contains five widgets: the window titled "Lissajous Curve", a vector of four entries, two linked radio buttons (<lines> and <points>), and a <Plot> button.

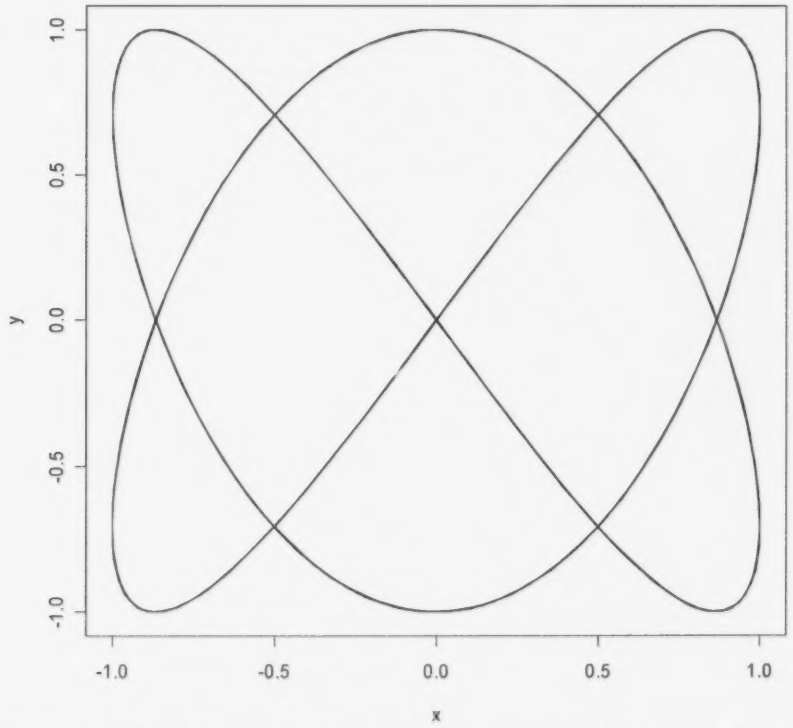


Figure 4. Default graph for the "Lissajous Curve" project, obtained by clicking the <Plot> button in Figure 3. The x variable goes through two cycles while the y variable goes through 3 cycles. A line graph is drawn through 1000 points generated by the algorithm (1).

The description file (Table 1) specifies a `window` titled "Lissajous Curve" with a `vector` of four entries. These correspond to quantities with the R variable names `m`, `n`, `phi`, and `k`. The corresponding window (Figure 3) will contain four entry boxes that allow these quantities to be changed. A label for each quantity emphasizes its conceptual role: the number of cycles for x or y, the phase shift for y, and the number of points plotted. Initial values correspond to those listed in (2). The backslash (\) character indicates that a widget description (in this case, a `vector`) continues on the next line. A pair of `radio` buttons, both corresponding to an R variable named `ptype`, allow selection between "lines" and "points" when drawing the plot. The graph (Figure 4) is actually drawn (i.e., the R function `drawLiss` is called) when the user presses a `button` that contains the text "Plot". In general, we use the symbols <...> to designate a button or keystroke, such as the <Plot> button or the radio buttons <lines> and <points>.

The file of R code (Table 1) implements the algorithm (1) for computing k points on a Lissajous curve. The function `drawLiss` has no arguments, but gets values of the R variables `m`, `n`, `phi`, `k`, and `ptype` from the GUI window via a call to the *PBS Modelling* function `getWinVal`. The argument `scope="L"` implies that these variables have local scope within this function only. (Another choice `scope="G"` would give the variables global scope by writing them to the user's global environment `.GlobalEnv`.)

2.2. Window description file

A window description file currently supports the following 18 widgets:

1. `window` – an entire new window;
2. `menu` – a menu grouping;
3. `menuitem` – an item in a menu;
4. `grid` – a rectangular block for placing widgets;
5. `label` – a text label;
6. `button` – a button linked to an R function that runs a particular analysis and generates a desired output, perhaps including graphics;
7. `check` – a check box used to turn a variable on or off, with corresponding values `TRUE` or `FALSE`;
8. `radio` – one of a set of mutually exclusive radio buttons for making a particular choice;
9. `null` –a blank widget that can occupy an empty space in a grid;
10. `entry` – a field in which a scalar variable (number or string) can be altered;
11. `text` – an entry box that supports multiple lines of text;
12. `vector` – an aligned set of entry fields for all components of a vector;
13. `matrix` – an aligned set of entry fields for all components of a matrix;
14. `data` – an aligned set of entry fields for all components of a data frame, where columns can have different modes;
15. `object` – an aligned set of entry fields defined by an existing R-object (vector, matrix, or data frame);
16. `slide` – a slide bar that sets the value of a variable;

17. `slideplus` – an extended slide bar that also displays a minimum, maximum, and current value;
18. `history` – a device for archiving parameter values corresponding to different model choices, so that a "slide show" of interesting choices can be preserved.

The description file is an ordinary text file that specifies each widget on a separate line. However, any one widget description can span multiple lines by using a backslash character (\) to indicate the end of an incomplete line. For example, the single line:

```
label text="Hello World!"
```

is equivalent to:

```
label \
  text="Hello World!"
```

Meaningful indentation is highly recommended, but not compulsory. The three-line description of a `vector` widget in Table 1 illustrates a readable style.

Each widget has named arguments that control its behaviour, analogous to the named arguments of a function in R. Some (required) arguments must be specified in the widget description. Others (not required) can take default values. All widgets have a `type` argument equal to one of the 18 names above, although the word `type` can be omitted in the description file. Appendix A gives an alphabetic list of all these widgets, along with detailed descriptions of all arguments. As in calls to R functions, argument names can be omitted as long as they conform to the order specified in the detailed widget descriptions given below. Nevertheless, we recommend that all argument names be specified, except possibly the name `type`, which is always the first argument for each widget. Unlike R functions, where commas separate arguments, the arguments in a widget description are separated by white space.

In a description file, all argument values are treated initially as strings. In addition to specifying a line break, the backslash can be used to indicate five special characters: single quote \', double quote \", tab \t, newline \n, and backslash \\. If an argument value does not include spaces or special characters, then quotes around the string are not required. Otherwise, double quotes must be used to delineate the value of an argument. Single quotes indicate strings nested within strings. For example, the `vector` in Table 1 has four labels specified by the string argument

```
labels="'x cycles' 'y cycles' 'y phase' points"
```

A hash mark (#) that is not within a string begins a comment, where everything on a line after the hash mark is ignored. As mentioned above, an isolated backslash (not part of a special character) indicates continuation onto the next line. A break can even occur in the middle of a string, such as the long label

```
label text="This long label with spaces \
  spans two lines in the description file"
```

In this case, leading spaces in the second line are ignored, to allow meaningful formatting in the description file. Intentional spaces in a long string should appear prior to the backslash on the first line.

Although the `type` argument (like `vector`) for a widget can never be abbreviated, other arguments follow the convention used with named arguments in R function calls. For a given widget type, the available arguments can be abbreviated, as long as the abbreviations uniquely identify each argument. For example, the `vector` in Table 1 could be specified as:

```
vector len=4 nam="m n phi k"                          \
  lab="'x cycles' 'y cycles' 'y phase' points" \
  val="2 3 0 1000"
```

Unlike variable names in R, widget names and their arguments are not case sensitive. Some users may prefer to write all `type` variables in upper case or with an initial capital letter. For example, the names WINDOW, VECTOR, RADIO, and BUTTON could be used to emphasize the widgets in Table 1.

2.3. Window support functions

PBS Modelling includes functions designed to connect R code with GUI windows. Every `window` has a `name` argument (with default `name=window`), and windows with different names can coexist. Window names must use only letters and numbers; they cannot contain a period (dot) or any other punctuation. When running a program with multiple windows, only one window will be current (i.e., selected by the user) at any particular time. Normally, a user selects a window by clicking on it, but the function `focusWin` allows program control of the window currently in focus. Thus, activity in one window might be used to shift the focus to another.

The function `createWin` uses a description file to generate one or more windows, where each window has a distinct name (perhaps the default) taken from the file. If a window with the specified name already exists, it will be closed before the new window is opened. When designing and testing a GUI, this feature ensures that a new version automatically replaces the previous one. The function `closeWin`, which takes a vector of window names, closes all windows named in the vector. With no arguments, `closeWin()` closes all windows that are currently open.

Although `createWin` normally builds a GUI from a description file, it will also accept a vector of strings equivalent to such a file. Thus, a file of R source code can define a GUI directly, without the need for a separate description file. illustrates how this can be done in a simple case. To see the character vectors equivalent to a given description file (say, `winDesc.txt`), type the R command:

```
scan("winDesc.txt",what=character(),sep="\n")
```

In particular, if the description file includes a backslash or double quote character, the corresponding R string must represent it as `\\` or `\"`, respectively. Despite this alternative of embedding window descriptions in R source files, we recommend writing separate files to define GUIs, except perhaps for very simple models.

Table 2. A simple file of R source code with character strings that define a GUI. No separate window description file is required.

File: Simple.r

```
# window description strings
winStr=c(
  "window",
  "entry name=n value=5",
  "button function=myPlot text=\"Plot sinusoid\"");

# function to plot a sinusoid
myPlot <- function() {
  getWinVal(scope="L");
  x <- seq(0,500)*2*n*pi/500;
  plot(x,sin(x),type="l"); };

# commands to create the window
require(PBSmodelling); createWin(winStr,astext=TRUE)
```

Internally, *PBS Modelling* converts a description file into a `list` object that is used to generate the corresponding GUI. The functions `compileDescription` and `parseWinFile` give lists that correspond to description files. Just as `createWin` can act directly on a character vector, it can also act on a suitably defined list, rather than a file. This feature makes it possible to replace a description file with R code that defines the corresponding list, although we recommend against this practice in most cases.

R programs need to share data with a GUI window. *PBS Modelling* provides six functions that deal with values of R variables named in a description file:

- `getWinVal` returns values from the current window;
- `setWinVal` sets values in the current window;
- `getWinAct` returns all actions (up to a maximum of 50) invoked in the current window;
- `setWinAct` adds an action to the action vector for the current window;
- `getWinFun` returns the names of all R functions referenced in the current window;
- `clearWinVal` clears global values associated with the current window.

Some models make use of a single parameter vector. In such cases the function `createVector` generates a GUI directly, without the need for a corresponding description file.

After using `createWin` to produce a GUI, the functions `getWinVal` and `getWinFun` provide useful summaries of names declared in the current project. Furthermore, the function `getWinAct` provides a record of GUI actions taken by the user, starting with the most recent and working backwards. By default, the `action` associated with a widget is its type; for example a `button` has default `action=button`. In general, however, the description file could give a unique action name to each potential action, so that the vector would give an unambiguous record of user actions.

Two functions provide support for selecting a file from a GUI:

- `promptOpenFile` shows the current directory for choosing a file to open;
- `promptSaveFile` shows the current directory for naming a file to save.

Files can be opened in programs external from R depending on their file extension:

- `openFile` opens a file using the default program for the file extension;
- `setPBSext` overrides the default program associated with an extension;
- `getPBSext` shows the overridden file extension and associated program.

If a widget invokes the function `openFile`, the associated `action` should be the file name. By definition, `openFile` has the default argument `getWinAct()[1]`.

On a Windows platform, the native R function `shell.exec` (called by `openFile`) automatically chooses a default from the registry. For this reason, our distribution specifies an empty list:

`getPBSext()` returns `list()`.

The default can, however, be overwritten by specifying explicit list components, such as:

```
setPBSext('html',
  '"c:/Program Files/Mozilla Firefox/firefox.exe" file://%f')
```

where `%f` denotes the file name in the string passed to the operating system. On Unix platforms, it may be essential to specify defaults this way. Future versions of our library may include other options, such as default width for a data entry field or the maximum number of `actions`.

PBS Modelling includes a `history` widget designed to collect interesting choices of GUI variables so that they can be redisplayed later, rather like a slide show. This widget has buttons to add and remove GUI settings from the current collection, to scroll backward and forward, and to clear all entries from the collection. Other buttons allow entire history files to be saved or loaded. The `history` widget defines and uses the list `PBS.history` in the global environment to store a saved history.

Normally, a user would invoke a `history` widget simply by including a reference to it in the description file. However, *PBS Modelling* includes some support functions for customized applications:

- `initPBShistory` initializes data structures for holding a collection of history data;
- `addPBShistory` saves the current window settings to the current history record;
- `rmPBShistory` removes the current record from the history;
- `backPBShistory` and `forwPBShistory` move backward and forward between successive history records;
- `jumpPBShistory` moves to a specified record in the history;
- `exportPBShistory` and `importPBShistory` save and load histories from files;
- `clearPBShistory` removes all records from the current collection.

The help file for `initPBShistory` shows an example that uses these functions directly.

2.4. Internal data

PBS Modelling uses the hidden list variable `.PBSmod` in the global environment to store current settings and internal information needed to communicate with the `tcl/tk` interface. This variable is intended for exclusive use by *PBS Modelling*, and users should not alter or delete it while *PBS Modelling* is active. We include the material in this section for advanced users and developers interested in further details about the internal data used to manage GUI windows.

The list `.PBSmod` contains a named component for each open window, where the component name matches the window name. Recall that, if a window is not named explicitly, it receives the default `name=window`. In addition to window names, `.PBSmod` contains two other named components: `$.activeWin` and `$.options`. These names do not conflict with the window names, because the latter cannot include a dot `(.)`.The `$.activeWin` component stores the name of the window that has most recently received user input. The `$.options` component currently has only one element `$openfile`, with information that links programs to file extensions for the function `openFile`.

Any named component of `.PBSmod` that does not start with a dot stores information related to the corresponding window. Each window uses a list with the following named components:

- `widgetPtrs`
  A list containing widget pointers. Each component has a name that matches widget name. Only widgets with a `name` argument and a corresponding `tk` widget will appear in this list.
- `widgets`
  A list containing information from the window description file relevant to each widget. This list includes every widget that has a `name` or `names` argument. Widgets without names will never be referenced again after the window has been created; consequently, information about them is not stored for later usage.
- `tkwindow`
  A pointer to the window created by `tktoplevel()`.
- `functions`
  A vector of all function names referenced in the window description.
- `actions`
  A vector containing `action` strings corresponding to the most recent user actions in the window, up to a maximum of 50. (The internal constant `.maxActionSize` sets this upper limit. See the file `defs.R` in the distribution source code.)

Users can explore the contents of `.PBSmod` with the R structure command `str`. For example, from the R console, type `runExamples()` and select the example "CalcVor". Then type the command `str(.PBSmod,2)` to shows the list structure to a depth of 2. This reveals all the list components discussed above. Further details appear by exploring the structure to depths 3, 4, or more. Notice also how the contents change as different examples are selected.

The functions `getWinVal`, `setWinVal`, `getWinAct`, `setWinAct`, `getWinFun`, `getPBSext`, and `setPBSext` (discussed in Section 2.3) provide methods for manipulating and retrieving variables stored in `.PBSmod`. Use these, rather than direct access, to alter the internal data. Future design modifications to *PBS Modelling* might change the architecture for storing the data components, but the methods functions will continue to have their current effect.

Table 3. Sample data file for *PBS Modelling*. The function `readList` converts this file to a `list` object with six components: a scalar `$x`, a logical vector `$y`, two matrices (`$z`, `$a`), and two data frames (`$b1`, `$b2`). The matrix `$a` is read by column, and `$b1=$b2`.

```
$x
0

$y
T F TRUE FALSE

$z
11.1 12.2 13.3 14.4
15.5 16.6 17.7 1.88e+01

$a
$$matrix ncol=2 byrow=FALSE colnames="a b"
5 1 2 3

$b1
$$data ncol=3 modes="numeric logical character" \
  byrow=TRUE colnames="N L C"
5 T aa
3 F bb
8 T cc
10.5 F dd

$b2
$$data ncol=3 modes="numeric logical character" \
  byrow=FALSE colnames="a b c"
5 3 8 10.5
T F T F
aa bb cc dd
```

3. Functions for data exchange

Computer models usually require data exchange between model components. For example, as described above, the functions `getWinVal` and `setWinVal` move data between an R program and the GUI. Other applications, such as those written separately in C, may have the ability to write data to files that R can read. In cases like this, it would be convenient to have

variable names in the C code correspond to variables with the same names in R. *PBS Modelling* can facilitate this process with the functions `readList` and `writeList`, which convert a text file to an R `list` and vice-versa. Another function `unpackList` creates local or global variables with names that match the list components.

Table 3 illustrates a data file in PBS format, legible by `readList`. The file contains lines with an initial dollar sign (like `$x` in Table 3) that specify a list component name in R, followed by one or more lines of data. Data items are separated by white space. A single item of data corresponds to a scalar in R, multiple items on a single line correspond to a vector, and multiple lines of data correspond to a matrix with the number of columns determined by the first line of data. Thus, in Table 3, `$x` is a scalar, `$y` is a vector of length 4, and `$z` is a 2×4 matrix. The format also supports four possible data type definitions on a line preceded by `$$`:

```
$$ vector mode=numeric names=""
$$ matrix mode=numeric ncol rownames="" colnames="" byrow=TRUE
$$ data modes=numeric ncol rownames="" colnames byrow=TRUE
$$ array mode=numeric dim fromright=TRUE
```

Table 3 illustrates their use in specifying `$a`, `$b1`, and `$b2`. Matrices and data frames can be read by row or column. This choice determines the order of reading the data, and white space (including line breaks) merely signifies breaks between data items. Array objects with three or more dimensions can be read in two ways, with indices varying first from the right or from the left. For example, data for an array indexed by `[i,j,k]` are read by varying `i` first with fixed `j` and `k` if `fromright=TRUE`. Similarly, `k` varies first if `fromright=FALSE`.

As in widget descriptions, arguments may be omitted in favour of their defaults, and the `$$` line may be continued across multiple lines by using a backslash character `\`. For a `matrix`, the argument `ncol` is required. Similarly, a `data` object (i.e., a data frame) must specify `ncol` and a vector `colnames` of length `ncol`. Also, `modes` must have length 1 (so that all entries in the data frame have the same mode) or length `ncol`. An `array` must have a complete `dim` argument, a vector giving the number of dimensions for each index.

As indicated earlier, *PBS Modelling* can use this specialized data format as a convenient means of capturing data from other programs. For example, to export data from an external C program, write C code that generates a data file in PBS format, where component names in the file match the C variable names. Then read the resulting file into an R session with the function `readList`, and use `unpackList` to produce local or global R variables. At this point, both R and C share data with the same variable names. This method works well with programs written for *AD Model Builder* (http://otter-rsch.ca/admodel.htm), a package used extensively in fishery research and other fields. It uses reverse automatic differentiation (AD; Griewank 2000) for highly efficient calculation of maximum likelihood estimates.

To considerable extent, R has native support for reading and writing a variety of text files, including the functions `scan`, `cat`, `source`, `dump`, `dget`, `dput`, `read`, `write`, `read.table`, and `write.table`. External programs sometimes utilize R formats for their input data. For example, the program *WinBUGS* (Speigelhalter et al., 2004), which implements Bayesian inference using Gibbs sampling, uses data files written in a list format closely related to

the R syntax produced by the `dput` function. If the file `myData.txt` has `dput` format, then either of the two R commands

```
myData <- dget("myData.txt");
myData <- eval(parse("myData.txt"));
```

produces a corresponding R list object named `myData`.

We should, however, add a word of caution here. When R saves array data in `dput` format, it converts the array to a vector by varying the indices from left to right. For example, a matrix with indices `[i,j]` is saved as a vector in which `i` varies for each fixed `j`. In effect, the data are stored by column. This sometimes gives an unnatural visual appearance. In English, the eye reads naturally from left to right, then down. Matrices are normally displayed by row, with column index `j` varying for each fixed `i`. *WinBUGS*, supported by the R package *BRugs* (Thomas 2004), requires input data formatted in this visually meaningful way. More generally, *WinBUGS* reads arrays by varying the indices from right to left. The *BRugs* function `bugsData` writes data in this format, but users must take special care in reading *WinBUGS* data with the `dget` function.

4. Support functions for graphics and analysis

As mentioned in the preface, we have devised a number of functions that make it easier for us to work in R. Some of them, such as `plotBubbles`, relate to techniques discussed in our published work (e.g., Richards et al. 1997; Schnute and Haigh 2007). Others just provide convenient utilities. For example, `testCol("red")` shows all colours in the palette `colors()` that contain the string `"red"`. We also provide support for a few analytical methods, such as function minimization. This section gives a brief description of *PBS Modelling* support functions. See the help files for further information.

4.1. Graphics utilities

`resetGraph`.....Reset various graphics parameters to defaults, with `mfrow=c(1,1)`.
`expandGraph`.....Set various graphics parameters to make graphs fill out available space.

`drawBars`.....Draw a linear bar plot on the current graph.
`genMatrix`.....Generate a test matrix for use in `plotBubbles`.
`plotACF`.....Plot autocorrelation bars (ACF) from a data frame, matrix, or vector.
`plotAsp`.....Plot a graph with a prescribed aspect ratio, preserving `xlim` and `ylim`.
`plotBubbles`.....Construct a bubble plot for a matrix.
`plotCsum`.....Plot cumulative sum of a vector, with value added.
`plotDens`.....Plot density curves from a data frame, matrix, or vector.
`plotTrace`.....Plot trace lines from a data frame, matrix, or vector.

`addArrows`.....Call the `arrows` function using relative (0:1) coordinates.
`addLegend`.....Add a legend using relative (0:1) coordinates.
`addLabel`.....Add a panel label using relative (0:1) coordinates.

`pickCol`.....Pick a colour from a complete palette and get the hexadecimal code.
`testCol`.....Display named colours available based on a set of strings.
`testLty`.....Display line types available.
`testLwd`.....Display line widths.
`testPch`.....Display plotting symbols and backslash characters.

4.2. Data management

`clearAll` .....Function to clear all data in the global environment.
`pad0`.....Pad numbers with leading zeroes (string).
`show0`.....Show decimal places including zeroes (string).
`unpackList`.....Unpack the objects in a list and make them available locally or globally.
`view`.....View the first *n* rows of a data frame or matrix.

4.3. Function minimization and maximum likelihood

Three functions in the `stat` library support function minimization in R: `nlm`, `nlminb`, and `optim`. These tend to perform slowly compared with other software alternatives, due partly to R's interpretive function evaluation. Nevertheless, for small problems they offer a convenient means of analysis, based entirely on code written in R. Our examples illustrate some of the possibilities. For large problems coded in other software, we still like to write independent code for a function in R, based only on the model documentation. If both versions of the software produce the same function values at selected values of the function arguments, then we have greater confidence that we have represented our model correctly in code. In that context, R serves as a valuable debugging tool.

PBS Modelling provides a support function `calcMin` that can use any method available in the `stat` library to find the vector $(\hat{x}_1,\ldots,\hat{x}_n)$ of length n that minimizes the function $y = f(x_1,\ldots,x_n)$. In practice, we usually apply this to the negative log likelihood for a statistical model, where the variables x_i are parameters. We define a new class `parVec`, which is a data frame with four columns:

- `val` – the actual value of parameter x_i;
- `min` – a minimum allowable value of x_i;
- `max` – a maximum allowable value of x_i; and
- `active` – a logical value that determines whether or not the minimization algorithm should vary the value of x_i. If `active=F`, then x_i remains unchanged at the value `val`.

Internally, `calcMin` scales active variables x to surrogate variable s in the range [0,1], where x and s are related by the inverse formulas (Schnute and Richards 1995, p. 2072):

$$x = x_{\min} + (x_{\max} - x_{\min})\frac{1-\cos(\pi s)}{2} = x_{\min} + (x_{\max} - x_{\min})\sin^2\left(\frac{\pi s}{2}\right), \tag{4.3a}$$

$$s = \frac{1}{\pi}\operatorname{acos}\left(\frac{x_{\max} + x_{\min} - 2x}{x_{\max} - x_{\min}}\right) = \frac{2}{\pi}\operatorname{asin}\sqrt{\frac{x - x_{\min}}{x_{\max} - x_{\min}}}\,. \tag{4.3b}$$

All these formulas represent equivalent forms of a one-to-one relationship $x \leftrightarrow s$, where $x_{\min} \le x \le x_{\max}$ and $0 \le s \le 1$. Readers may find the second versions of (4.3a) and (4.3b) more intuitive (with a familiar "arc sine square root" transformation in (4.3b)), but the code uses the first versions for a possible improvement in computational efficiency by avoiding square and square root functions. The minimization algorithm works entirely with surrogate variables, which may have dimension smaller than n if some variables x_i are not active. The function `scalePar` scales an object x of class `parVec` x to a vector s of surrogates via the formula (4.3b). Similarly, `restorePar` recovers x from s via (4.3a).

We also provide a convenient function `GT0` that restricts a numeric variable x to a positive value defined by

$$\texttt{GT0}(x,\varepsilon) = \begin{cases} x, & x \ge \varepsilon \\ \dfrac{\varepsilon}{2}\left[1 + \left(\dfrac{x}{\varepsilon}\right)^2\right], & 0 < x < \varepsilon \\ \dfrac{\varepsilon}{2}, & x \le 0 \end{cases}. \tag{4.3c}$$

The notation `GT0` denotes "greater than zero". This function preserves the value of x if $x \ge \varepsilon$, and for smaller values x it is always true that $\texttt{GT0}(x,\varepsilon) \ge \frac{\varepsilon}{2}$. The function (4.3c) also has a continuous first derivative that makes sense locally on a small scale of size ε. This property makes it useful for avoiding unrealistic numbers that might be negative or zero, particularly when the minimization algorithm uses derivatives of the objective function.

In summary, *PBS Modelling* has four functions that facilitate function minimization.

`calcMin`.....Calculate the minimum of a user-defined function.
`scalePar` .....Scale parameters to surrogates in the range [0,1].
`restorePar`.....Restore actual parameters from surrogate values.
`GT0` .....Restrict a numeric variable to a positive value ("Greater Than 0").

4.4. Handy utilities

`calcFib`.....Calculate Fibonacci numbers (included only to illustrate the use of C code).
`calcGM`.....Calculate the geometric mean of a vector of numbers.
`findPat`.....Find all strings that include any string in a vector of patterns.

`pause`.....Pause, typically between graphics displays.
`showArgs`.....Show the arguments for a specified widget in Appendix A.
`testWidgets`.....GUI to test all widgets listed in Appendix A.
`view`.....View the first few lines of a (potentially large) matrix or data frame.

5. Examples

As mentioned in the Preface, *PBS Modelling* includes a variety of examples that illustrate applications based on this and other libraries. Generally, each example contains documentation, R code, a window description file, and (if required) other supporting files. All relevant files appear in the R library directory `PBSmodelling\Examples`. An example named `xxx` typically has corresponding files `xxxDoc.txt` or `xxxDoc.pdf` (documentation), `xxx.r` (R code), and `xxxWin.txt` (a window description). In the GUI for each example, buttons labelled `Docs`, `R Code`, and `Window` open these files **provided that suitable programs have been associated with the file extensions `*.txt`, `*.pdf`, and `*.r`.** In particular, the Acrobat Reader must be installed for reading `*.pdf` files, and you may need to associate a text file editor with `*.r`. On some systems, it may be necessary to use the function `setPBSext` to define these associations, as discussed earlier in Section 2.3.

Use the function `runExamples()` to view all examples available in *PBS Modelling*. This procedure copies all relevant files to a temporary directory located on the path defined by the environment variable `Temp`. It then opens a window in which radio buttons allow you to select any particular case. Closing the menu window causes the temporary files and related data to be cleaned up, and returns to the initial working directory.

Alternatively, you can copy all the files from `PBSmodelling\Examples` to a directory of your choice and open R in that working directory. To run example `xxx`, type `source("xxx.r")` on the R command line. For instance, `source("LissFig.r")` creates a window (from the description file `LissFigWin.txt`) that can be used to draw the Lissajous figures described in Section 2.1. The built-in example also includes a history widget for collecting settings that the user wishes to retain.

The examples documented here illustrate only some of those available in version 1 of *PBS Modelling*. For instance, we also include a `TestFuns` GUI that we have used as a tool for debugging various functions in the package. In future versions, we plan to add more examples that illustrate important modelling concepts and provide convenient supplementary materials for university courses in fisheries, biology, ecology, statistics, and mathematics. The function `runExamples()` should always represent the complete list currently available, and the `Docs` button for each case should link to the appropriate documentation.

The nine examples presented in this section illustrate some of the possibilities available in *PBS Modelling*, although the documentation may be somewhat out of date. For example, the figures in this report may not correctly represent current versions of the GUIs and their

associated graphical output. Use the `Docs` button to read the most current information for each example. If this seems rather primitive, please wait for improvements in future versions.

5.1. Random variables

5.1.1. `RanVars` – Random variables

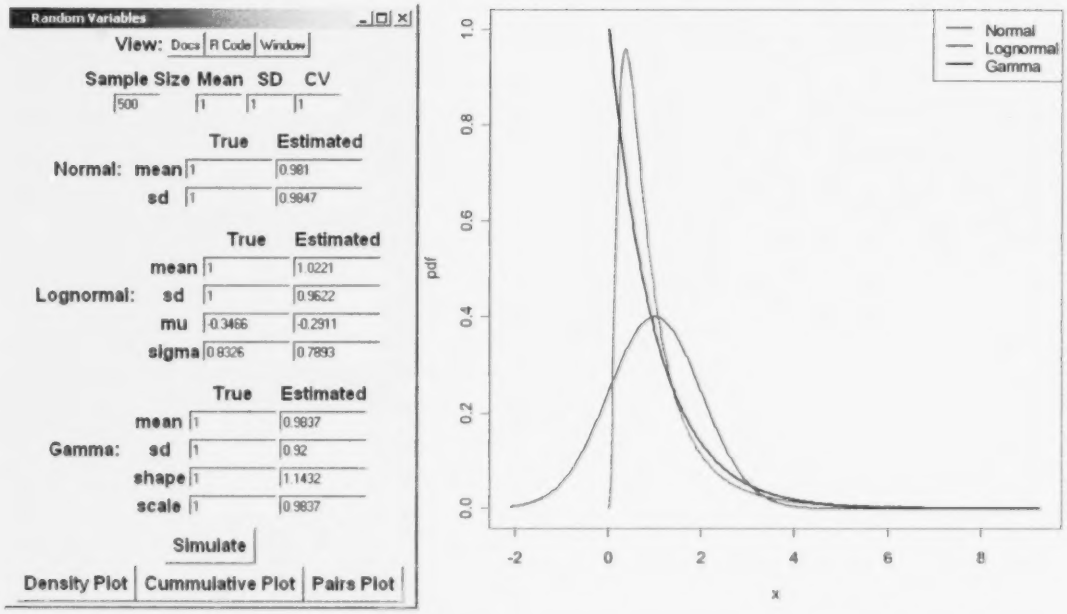


Figure 5. `RanVars` GUI (left) and density plot (right). Simulations are based on 500 random draws with mean =1 and SD = 1.

The `RanVars` example draws samples from three continuous random distributions (normal, lognormal, and gamma) with a common mean μ and standard deviation σ. The documentation ("Docs" button) shows relevant formulas that connect distribution parameters with the moments μ and σ Estimated parameter values from a simulation (invoked by "Simulate") are displayed in the GUI alongside the true values (Figure 5). We use only the straightforward moment formulas in the documentation, without sample bias correction formulas like those described by Aitchison and Brown (1969). Three buttons at the bottom of the GUI portray the data visually as density curves, cumulative proportions, and paired scatter plots.

5.1.2. RanProp – Random proportions

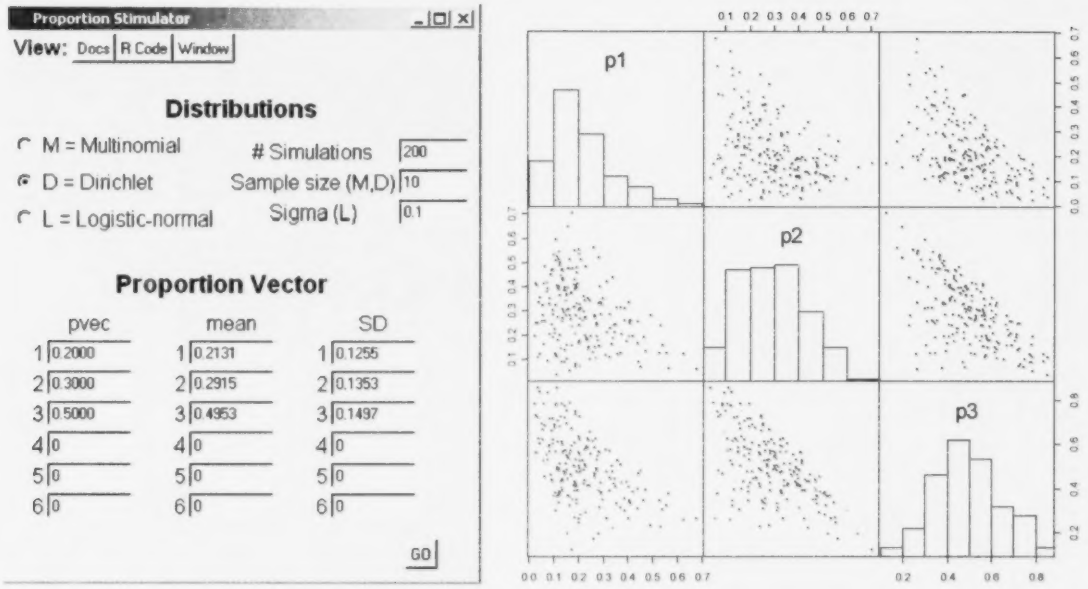


Figure 6. RanProp GUI (left) and pairs plot (right). Simulations are based on 200 random draws where $n = 10$ for the multinomial and Dirichlet distributions and $\sigma = 0.1$ for the logistic-normal distribution. The pairs plot portrays results for the Dirichlet.

The RanProp example simulates up to five random proportions drawn from one of three distributions – multinomial, Dirichlet, and logistic-normal. The observed proportion means and standard deviations are reported in the GUI (Figure 6), and a graphical display renders the points as a paired scatter plot. After defining options in the GUI, including the vector "pvec" of true underlying proportions, press "Go". Schnute and Haigh (2007) provide further technical details about these three distributions.

5.1.3. `SineNorm` – Sine normal

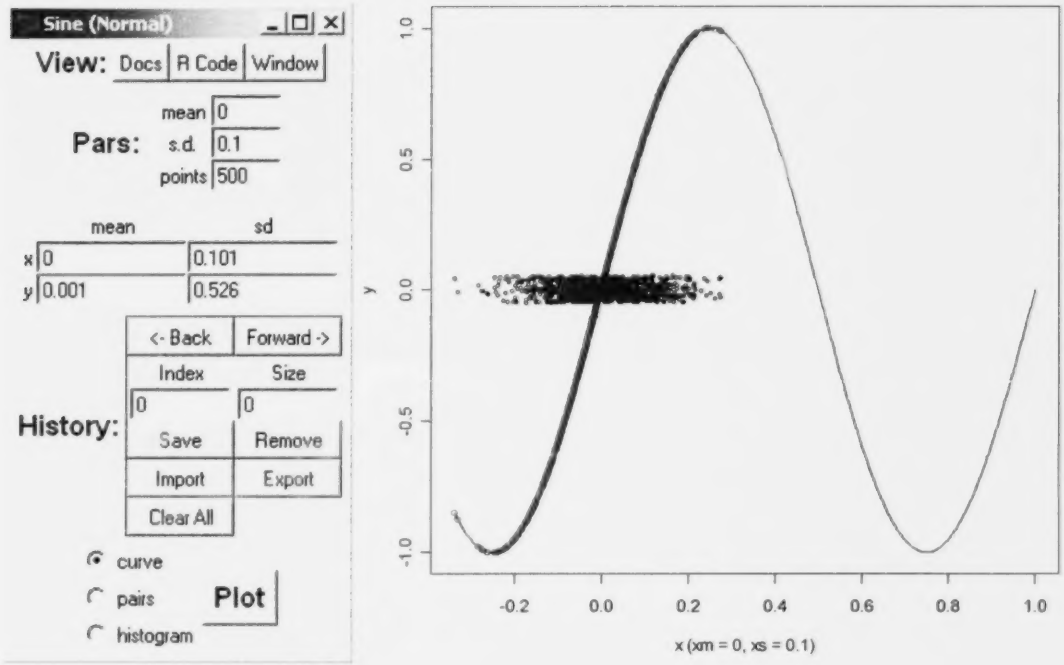


Figure 7. `SineNorm` GUI (left) and plot (right). Simulations are based on 500 random draws of $y = \sin(2\pi x)$, where x is normal with mean $\mu = 0$ and standard deviation $\sigma = 0.1$. Blue points portray jittered values of x, and red points show corresponding values of y.

The `SineNorm` example illustrates a somewhat unconventional random variable $y = \sin(2\pi x)$, where x is normal. The GUI allows you to specify the mean μ and standard deviation σ of x. If $\mu = 0$ and σ is small, the transformation is nearly linear, so that y is approximately normal. If σ is large, the transformation concentrates y near -1 and 1. Figure 7 illustrates the transformation when σ has the moderate value 0.1. Try $\sigma = 10$ to see how values y tend to occur near the peaks and troughs of the sine function, where the slope is relatively flat.

5.1.4. `CalcVor` – Calculate Voronoi tessellations

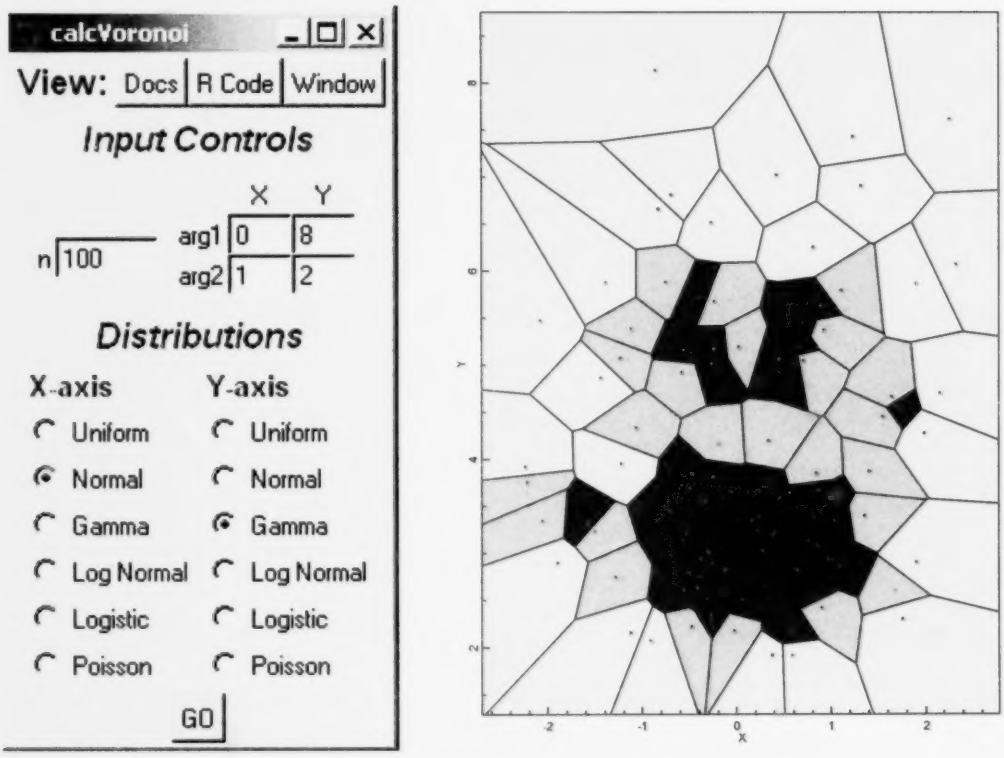


Figure 8. `CalcVor` GUI (left) and plot (right). Tessellation of random points (red) that are normally distributed on the x-axis (`mean=0`, `sd=1`) and gamma-distributed on the y-axis (`shape=8`, `rate=2`).

The `CalcVor` example calls *PBS Mapping*'s `calcVoronoi` function, which calculates the Voronoi (Dirichlet) tessellation for a set of points using the `deldir` function in the CRAN package *deldir*. The GUI accepts two arguments for each random distribution represented on each axis. The underlying functions and their arguments are:

Distribution	Function	Argument 1	Argument 2
Uniform	`runif`	`min`	`max`
Normal	`rnorm`	`mean`	`sd`
Gamma	`rgamma`	`shape`	`rate`
Log normal	`rlnorm`	`meanlog`	`sdlog`
Logistic	`rlogis`	`location`	`scale`
Poisson	`rpois`	`lambda`	`---`

5.2. Statistical analyses

5.2.1. LinReg – Linear regression

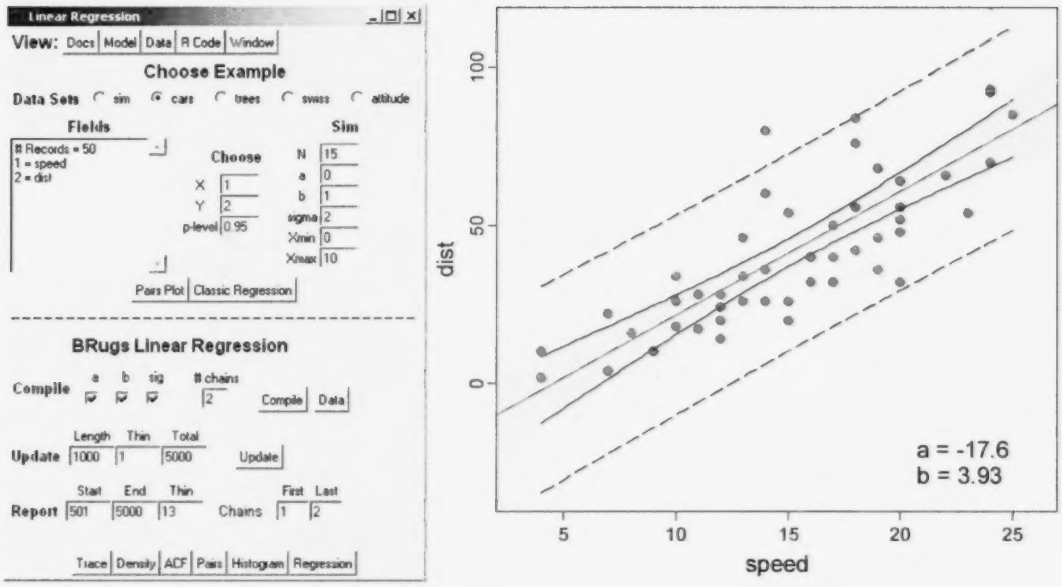


Figure 9. LinReg GUI (left) and regression plot (right). The linear regression uses the cars dataset (n=50) to predict dist vs. speed. The plot shows observations (green circles), fitted line (solid blue line), the 95% confidence limits of the fitted model (solid red lines), the 95% CL of the data (dashed purple lines), and the fits using the Bayes posterior estimates of (a,b) (gold lines).

The example LinReg estimates parameters in a linear regression $y = a + bx$ using either simulated data or data objects that come with the R-package. We compare a classical frequentist regression with results from Bayesian analysis, using the BRugs library to interface with the program WinBUGS. After selecting various data options, "Pairs Plot" shows a pairs plot (x, y) and "Classic Regression" adds confidence limits (at "p-level") from regression theory. Red and violet curves show bounds for a prediction or a new observation, respectively, each conditional on x. If the data came from simulation, a blue line portrays the truth, with specified values a and b, that must be estimated from the data.

A corresponding Bayesian analysis uses the WinBUGS model shown by pressing "Model". Choose parameters to monitor (normally all of them): the intercept a, the slope b, and the predictive standard deviation σ. After specifying a number of sample chains for the MCMC sample, press "Compile" to compile the model with these settings. "Update" generates samples in "Length" increments. Additional buttons at the bottom of the GUI allow you to explore the MCMC output. Posterior samples of (a, b) correspond to sample lines. The "Regression" button illustrates these in relationship to confidence limits from a frequentist analysis (Figure 9).

5.2.2. `MarkRec` – Mark-recovery

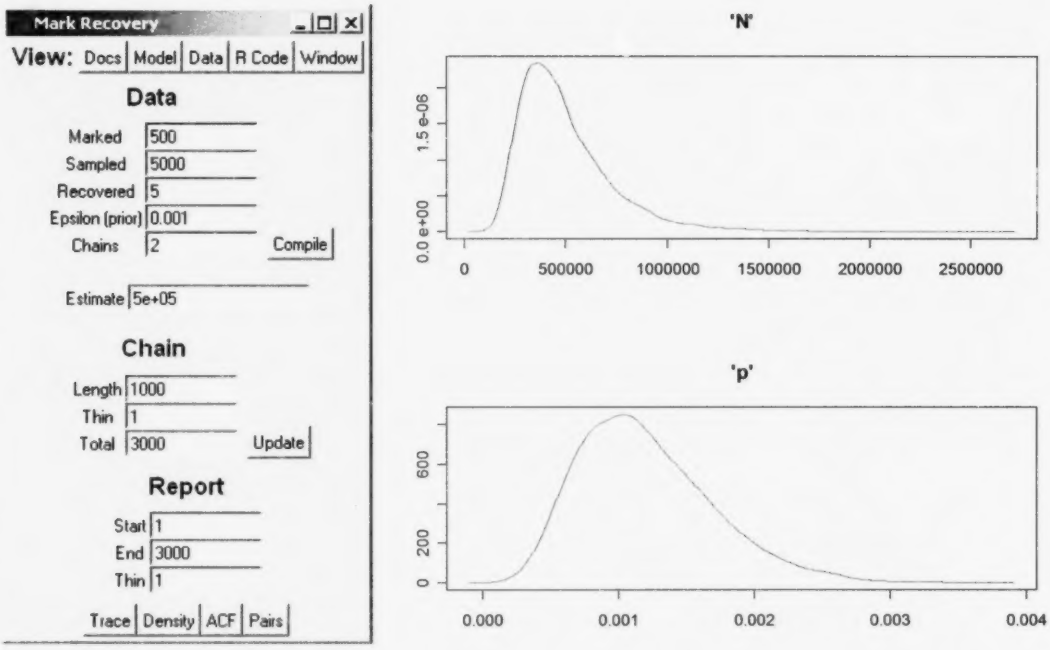


Figure 10. `MarkRec` GUI (left) and density plots (right). A low recovery of marked fish can lead to fat tails in N due to occasional large spikes in the population estimate.

The example `MarkRec` performs a Bayesian analysis of a mark-recovery experiment in which M fish are marked and allowed to disperse randomly in the population. Later, a sample of size S is removed from the population and R marks are recovered. Both the total population N and the marked proportion p are unknown, where

$$p = \frac{M}{N} \cong \frac{R}{S}.$$

In one version of the theory, R is binomially distributed with probability p in a sample of size S, and the above approximation suggests the estimate

$$\hat{N} = \frac{S}{R} M = \frac{M}{R} S.$$

When recoveries are low ($R \approx 0$), the posterior distribution of N exhibits a fat tail (Figure 10).

As in `LinReg`, "Model" shows the `MarkRec` model for WinBUGS, which (deliberately) includes an illegitimate prior that depends on the data. By increasing an initially small quantity ε, this fake prior allows the tail of N values to be arbitrarily clipped. Schnute (2006) gives some historical perspective to this analysis, in the context of work by W.E. Ricker.

5.2.3. CCA – Catch-curve analysis

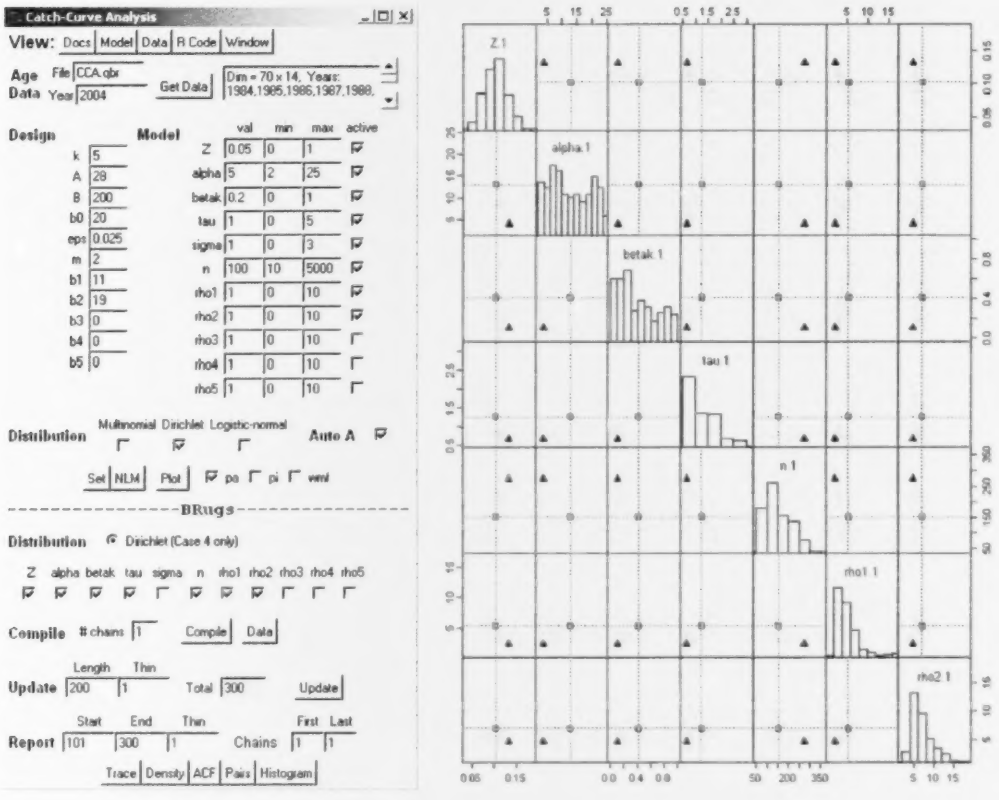


Figure 11. CCA GUI (left) and parameter pairs plot (right). Comparison of Bayes posterior distribution of CCA model parameter estimates from chain 1 (N=100). Symbols indicate means (blue squares) and modes (red triangles). Diagonal shows parameter estimate distributions.

The example CCA illustrates a catch-curve model proposed by Schnute and Haigh (2007). It incorporates effects of survival, selectivity, and recruitment anomalies on age structure data from a single year. After making various model choices, press "Set", "NLM" (which may take several seconds), and "Plot" to view the maximum likelihood estimates and their relationship with the data. A WinBUGS model ("Model") allows us to calculate posterior distributions. (See the last few lines of "Model".) As in `MarkRec`, select parameters to monitor, specify a number of chains, and "Compile" the model. "Update"s may be slow, but eventually they produce interesting posterior samples (Figure 11). "Docs" gives details of the deterministic model, and the Dirichlet distribution is used to describe error in the observed proportion.

We include this example to illustrate a somewhat realistic WinBUGS model that can be used to estimate parameters for a population dynamics model. We will provide further information when the paper (Schnute and Haigh 2007) is published. *PBS Modelling* includes the data for this example as the matrix `CCA.qbr`.

5.3. Other applications

5.3.1. FishRes – Fishery reserve

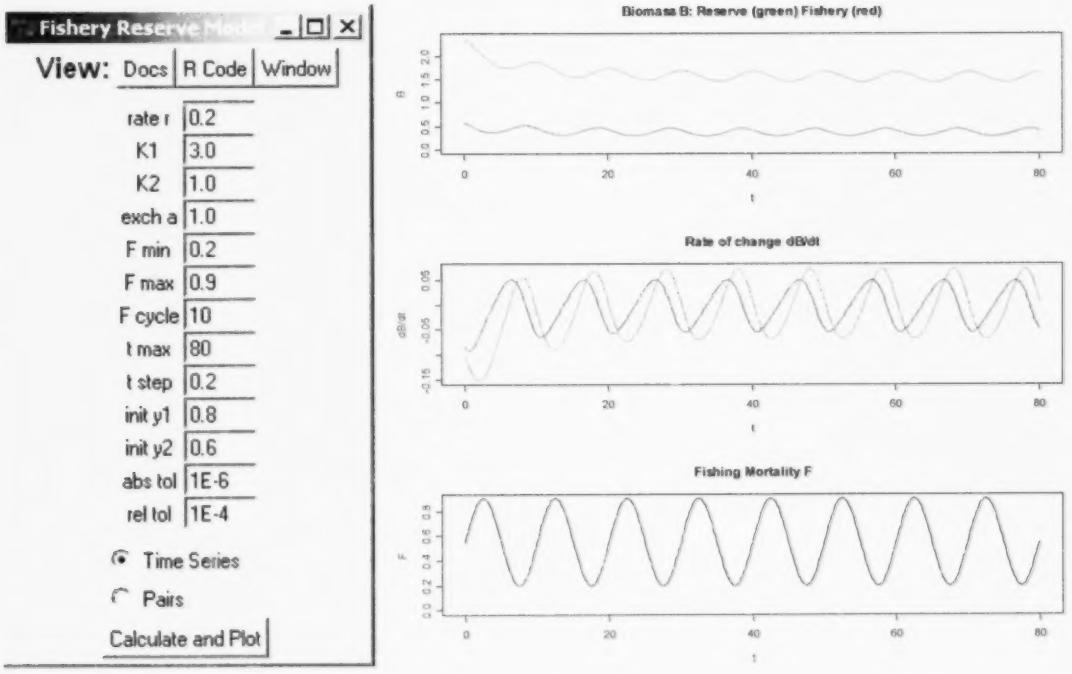


Figure 12. FishRes GUI (left) and time series (right) of population biomass, rates of biomass change, and fishing mortality.

The example FishRes models a fish population associated with a marine reserve using differential equations, which are solved numerically with the odesolve library. The dynamic equations:

$$\frac{dB_1}{dt} = rB_1\left(1-\frac{B_1}{K_1}\right)+a\left(\frac{B_2}{K_2}-\frac{B_1}{K_1}\right)$$

$$\frac{dB_2}{dt} = rB_2\left(1-\frac{B_2}{K_2}\right)-a\left(\frac{B_2}{K_2}-\frac{B_1}{K_1}\right)-F(t)B_2$$

$$F(t) = F_{\min}+\frac{F_{\max}-F_{\min}}{2}\left(1+\sin\frac{2\pi t}{n}\right)$$

describe the biomass B_i in region $i=1,2$, where region 1 is a reserve and region 2 experiences a periodic fishing mortality rate F, with minimum and maximum values $F_{\min}$ and $F_{\max}$. The two regions have a common growth rate r, but different carrying capacities K_i. A parameter a determines the movement rate from the region of higher density to the other region (Figure 12).

5.3.2. `FishTows` – Fishery tows

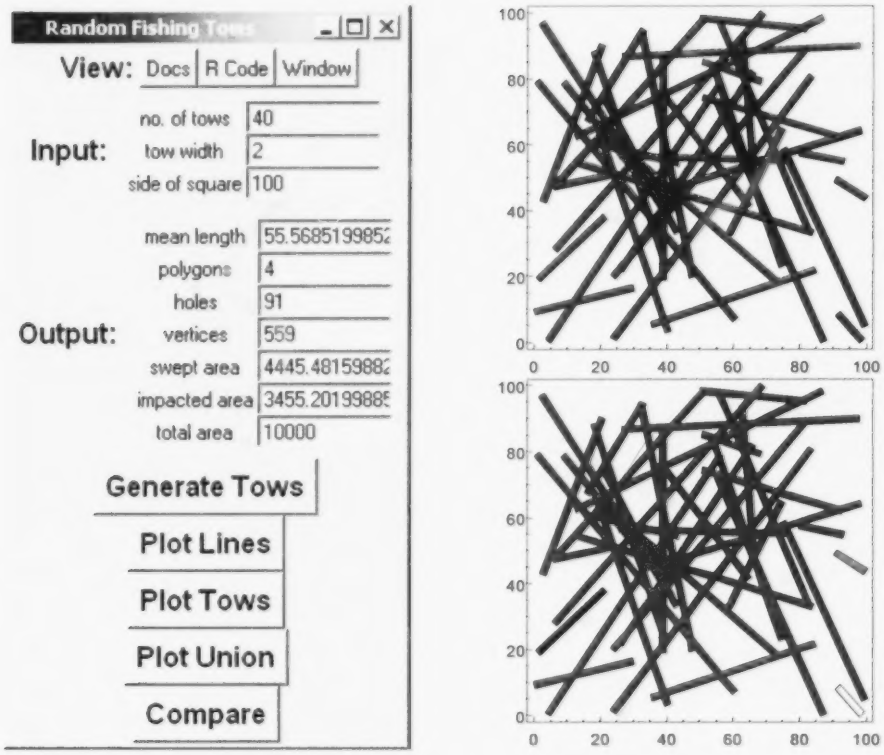


Figure 13. `FishTows` GUI (left) and simulated tow track (right). Tow track plots show 40 random tows in a square with side length 100. Each tow has width 2, and the rectangle encompasses 10,000 square units. *Top*: The individual rectangles, with 160 vertices, have areas that sum to 4,445 square units. *Bottom*: The union includes a complex polygon (red) and three isolated rectangles (blue, green, yellow) that cover only 3,455 square units. The complex polygon (red) has 547 vertices and 91 holes.

The example `FishTows` provides a simulator of fishery tow tracks using the `PBSmapping` library. The example demonstrates the difference between swept area and area impacted by trawls that often cover the same ground repeatedly. This application can be regarded an exotic random number generator, where tows initially join two points picked from a uniform random distribution within a square of a given side length. Three parameters (the number of tows, the tow width, the side length) determine several random variables, including the mean tow length, the areas swept and impacted, the numbers of polygons and holes in the union set of tows, and the number of vertices in the union. Each of these would also have a variance and an overall distribution generated by many runs of this example.

References

Aitchison, J., and Brown, J.A.C. 1969. The lognormal distribution, with special reference to its uses in economics. Cambridge University Press. Cambridge, UK. xviii+176 p.

Daalgard, P. 2001. A primer on the R Tcl/Tk package. *R News* 1 (3): 27–31, September 2001. URL: http://CRAN.R-project.org/doc/Rnews/

Daalgard, P. 2002. Changes to the R Tcl/Tk package. *R News* 2 (3): 25–27, December 2002. URL: http://CRAN.R-project.org/doc/Rnews/

Griewank A. (2000) Evaluating derivatives: principles and techniques of algorithmic differentiation. Frontiers in Applied Mathematics 19. Society for Industrial and Applied Mathematics

Ligges, U. 2003. R Help Desk: Package Management. *R News* 3 (3), 37–39. URL: http://CRAN.R-project.org/doc/Rnews/

Ligges, U, and Murdoch, D. 2005. R Help Desk: Make `'R CMD'` work under Windows – an example. *R News* 5 (2), 27–28. URL: http://CRAN.R-project.org/doc/Rnews/

Mittertreiner, A., and Schnute, J. 1985. Simplex: a manual and software package for easy nonlinear parameter estimation and interpretation in fishery research. Canadian Technical Report of Fisheries Aquatic Sciences 1384: xi+90 p.

Ousterhout, J.K. 1994. Tcl and the Tk toolkit. Addison-Wesley, Boston, MA. 458 p.

RDCT: R Development Core Team (2006a). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0. URL http://www.R-project.org. (Available in the current R GUI from "Help", "Manuals in PDF", "R Reference Manual")

RDCT: R Development Core Team (2006b). Writing R extensions. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-11-9. URL http://www.R-project.org. (Available in the current R GUI from "Help", "Manuals in PDF", "Writing R extensions")

Richards, L.J., Schnute, J.T., and Olsen, N. 1997. Visualizing catch-age analysis: a case study. Canadian Journal of Fisheries and Aquatic Sciences 54: 1646–1658.

Schnute, J. 1982. A manual for easy nonlinear parameter estimation in fishery research with interactive microcomputer programs. . Canadian Technical Report of Fisheries and Aquatic Sciences 1140. xvi+115 pp.

Schnute, J.T. 2006. Curiosity, recruitment, and chaos: a tribute to Bill Ricker's inquiring mind. Environmental Biology of Fishes 75: 95-110.

Schnute, J.T., Boers, N.M., and Haigh, R. 2003. PBS software: maps, spatial analysis, and other utilities. Canadian Technical Report of Fisheries and Aquatic Sciences 2496. viii+82 pp.

Schnute, J.T., Boers, N.M., and Haigh, R. 2004. PBS Mapping 2: user's guide. Canadian Technical Report of Fisheries and Aquatic Sciences 2549. viii+126 pp.

Schnute, J.T., and Haigh, R. 2007. Compositional analysis of catch curve data with an application to *Sebastes maliger*. ICES Journal of Marine Science. In press. Available at http://icesjms.oxfordjournals.org/papbyrecent.dtl, reference number doi:10.1093/icesjms/fsl024.

Schnute, J.T., and Richards, L.J. 1995. The influence of error on population estimates from catch-age models. Canadian Journal of Fisheries and Aquatic Sciences, 52: 2063–2077.

Spiegelhalter, D., Thomas, A., Best, N., and Lunn, D. 2004. WinBUGS User Manual, version 2.0. Available at http://mathstat.helsinki.fi/openbugs/.

Thomas, N. 2004. BRugs User Manual (the R interface to BUGS), version 1.0. Available at http://mathstat.helsinki.fi/openbugs/.

Appendix A. Widget descriptions

This appendix lists PBS Modelling widgets in alphabetical order. Details for each widget include a description, usage, arguments, and an illustrated example. In specifying a widget, the user can arrange named arguments in any order. If arguments are not named, they must appear in the order specified by the argument list, similar to named arguments in an R function.

Button

Description

A button linked to an R function that runs a particular analysis and generates a desired output, perhaps including graphics.

Usage

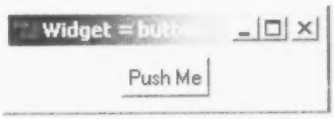
```
type=button text="Calculate" font="" fg="black" bg="" width=0
  function="" action="button" sticky="" padx=0 pady=0
```

Arguments

`text` .....text to display on the button
`font` .....font for labels – specify family (`Times`, `Helvetica`, or `Courier`), size (as point size), and style (`bold`, `italic`, `underline`, `overstrike`), in any order
`fg` .....colour for label fonts
`bg` .....background colour for widget
`width` .....button width, the default 0 will adjust the width to the minimum required
`function` .....R function to call when the button is pushed (i.e., clicked by the mouse)
`action` .....string value associated whenever this widget is engaged
`sticky` .....option for placing the widget in available space; valid choices are: `N`, `NE`, `E`, `SE`, `S`, `SW`, `W`, `NW`
`padx` .....space used to pad the widget on the left and right
`pady` .....space used to pad the widget on the top and bottom

Example

```
window title="Widget = button"
button text="Push Me"
```



Check

Description

A check box to turn a variable off or on, with corresponding values `FALSE` or `TRUE` (`0` / `1`).

Usage

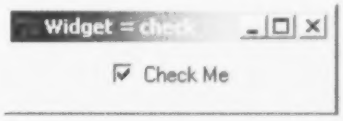
```
type=check name mode="logical" checked=FALSE text="" font=""
  fg="black" bg="" function="" action="check" sticky=""
  padx=0 pady=0
```

Arguments

`name` .....name of R variable altered by this check box (required)
`mode` .....R mode for the associated variable, where valid modes are `logical` or `numeric`
`checked` .....if `TRUE`, the box is checked initially and the variable is set to `TRUE` or `1`
`text` .....identifying text placed to the right of this check box
`font` .....font for labels – specify family (`Times`, `Helvetica`, or `Courier`), size (as point size), and style (`bold`, `italic`, `underline`, `overstrike`), in any order
`fg` .....colour for label fonts
`bg` .....background colour for widget
`function` .....R function to call when the check box is changed
`action` .....string value associated whenever this widget is engaged
`sticky` .....option for placing the widget in available space; valid choices are: `N`, `NE`, `E`, `SE`, `S`, `SW`, `W`, `NW`
`padx` .....space used to pad the widget on the left and right
`pady` .....space used to pad the widget on the top and bottom

Example

```
window title="Widget = check"
check name=junk checked=T text="Check Me"
```



Data

Description

An aligned set of entry fields for all components of a data frame. The `data` widget can accept a variety of modes. The user must keep in mind that `rowlabels` and `collabels` should conform to R naming conventions (no spaces, no special characters, etc.). If mode is logical, fields appear as a set of check boxes that can be turned on or off using mouse clicks.

Usage

```
type=data nrow ncol names modes="numeric" rowlabels=""
  collabels="" rownames="X" colnames="Y" font="" fg="black"
  bg="" entryfont="" entryfg="black" entrybg="white"
  values="" byrow=TRUE function="" enter=TRUE action="data"
  width=6 sticky="" padx=0 pady=0
```

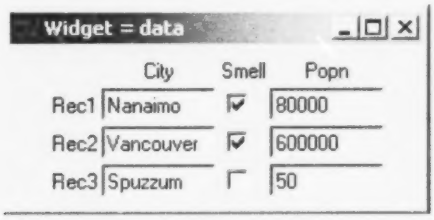
Arguments

`nrow`.....number of rows (required)
`ncol`.....number of columns(required)
`names`.....either one name or a set of `nrow*ncol` names used to store the data frame in R (required)
`modes`.....R modes for the data frame, where valid modes are: `numeric`, `integer`, `complex`, `logical`, `character`
`rowlabels`.....either one label or a vector of `nrow` labels used to label rows of this data frame in the display
`collabels`.....either one label or a vector of `ncol` labels used to label columns of this data frame in the display
`rownames`.....string scalar or vector of length `nrow` to name the rows of the data frame
`colnames`.....string scalar or vector of length `ncol` to name the columns of the data frame
`font`.....font for labels – specify family (`Times`, `Helvetica`, or `Courier`), size (as point size), and style (`bold`, `italic`, `underline`, `overstrike`), in any order
`fg`.....colour for label fonts
`bg`.....background colour for widget
`entryfont`.....font of entries appearing in input/output boxes
`entryfg`.....font colour of entries appearing in input/output boxes
`entrybg`.....background colour of input/output boxes
`values`.....default values (either one value for all data frame components or a set of `nrow*ncol` values)
`byrow`.....if `TRUE` and `nrow*ncol` names are used, interpret the names by row; otherwise by column. Similarly, interpret `nrow*ncol` initial values.
`function`.....R function to call when any entry in the data frame is changed
`enter`.....if `TRUE`, call the function only after the <Enter> key is pressed
`action`.....string value associated whenever this widget is engaged
`width`.....character width to reserve for the each entry in the data frame
`sticky`.....option for placing the widget in available space; valid choices are: `N`, `NE`, `E`, `SE`, `S`, `SW`, `W`, `NW`
`padx`.....space used to pad the widget on the left and right
`pady`.....space used to pad the widget on the top and bottom

Example

```
window title="Widget = data"
```

```
data nrow=3 ncol=3 names=Census byrow=FALSE \
     modes="character logical numeric" width=10 \
     rowlabels="Rec1 Rec2 Rec3" collabels="City Smell Popn" \
     values="Nanaimo Vancouver Spuzzum T T F 80000 600000 50"
```



Entry

Description

A field in which a scalar variable (number or string) can be altered.

Usage

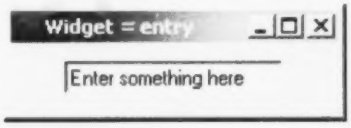
```
type=entry name value="" width=20 label="" font="" fg="" bg=""
  entryfont="" entryfg="black" entrybg="white" function=""
  enter=TRUE action="entry" mode="numeric" sticky="" padx=0
  pady=0
```

Arguments

`name` .....name of R variable corresponding to this entry (required)
`value`.....default value to display in the entry
`width`.....character width to reserve for the entry
`label`.....text to display above the entry box
`font` .....font for labels – specify family (`Times`, `Helvetica`, or `Courier`), size (as point size), and style (`bold`, `italic`, `underline`, `overstrike`), in any order
`fg`.....colour for label fonts
`bg`.....background colour for widget
`entryfont`.....font of entries appearing in input/output boxes
`entryfg`.....font colour of entries appearing in input/output boxes
`entrybg`.....background colour of input/output boxes
`function` .....R function to call when the entry is changed
`enter`.....if `TRUE`, call the function only after the <Enter> key is pressed
`action` .....string value associated whenever this widget is engaged
`mode`.....R mode for the value entered, where valid modes are: `numeric`, `integer`, `complex`, `logical`, `character`
`sticky`.....option for placing the widget in available space; valid choices are: `N`, `NE`, `E`, `SE`, `S`, `SW`, `W`, `NW`
`padx`.....space used to pad the widget on the left and right
`pady`.....space used to pad the widget on the top and bottom

Example

```
window title="Widget = entry"
entry name=junk value="Enter something here" width=20
     mode=character
```



Grid

Description

Creates space for a rectangular block of widgets. Spaces must be filled. Widgets can be any combination of available widgets, including `grid`.

Usage

```
type= grid nrow=1 ncol=1 toptitle="" sidetitle="" topfont=""
   sidefont="" byrow=TRUE borderwidth=1 relief="flat"
   sticky="" padx=0 pady=0
```

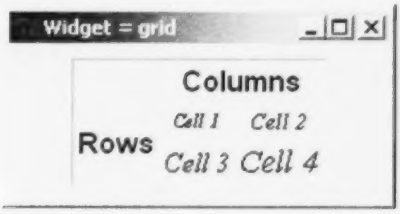
Arguments

`nrow` .....number of rows in the grid
`ncol` .....number of columns in the grid
`toptitle` .....title to place above grid
`sidetitle` .....title to place on the left side of the grid
`topfont` .....font for top labels – specify family (`Times`, `Helvetica`, or `Courier`), size (as point size), and style (`bold`, `italic`, `underline`, `overstrike`), in any order
`sidefont` .....font for side labels – specify family (`Times`, `Helvetica`, or `Courier`), size (as point size), and style (`bold`, `italic`, `underline`, `overstrike`), in any order
`byrow` .....if `TRUE`, create widgets across rows, otherwise down columns
`borderwidth` ...width of the border around the grid
`relief` .....type of border around the grid, where valid styles are: `raised`, `sunken`, `flat`, `ridge`, `groove`, `solid`
`sticky` .....option for placing the widget in available space; valid choices are: `N`, `NE`, `E`, `SE`, `S`, `SW`, `W`, `NW`
`padx` .....space used to pad the widget on the left and right
`pady` .....space used to pad the widget on the top and bottom

Example

```
grid 2 2 relief=groove toptitle=Columns sidetitle=Rows
     topfont="Helvetica 12 bold" sidefont="Helvetica 12 bold"
     label text="Cell 1" font="times 8 italic"
```

```
label text="Cell 2" font="times 10 italic"
label text="Cell 3" font="times 12 italic"
label text="Cell 4" font="times 14 italic"
```



History

Description

Allows the user to save and recover previous combinations of widget settings. A desired realization can be saved to a hidden stack using the `Add` button. Each saved realization has an `Index` within the stack of total saves `Size`. The user can scroll `back` and `forward` through the stack, invoking saved widget settings. Realizations no longer desired can be deleted using the `Remove` button.

Usage

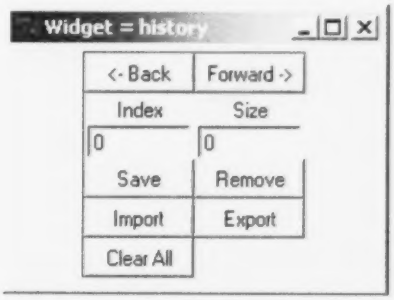
```
type=history name="default" archive=TRUE sticky="" padx=0
   pady=0
```

Arguments

`name` .....name of history archive
`archive` .....if TRUE, user can import previous sessions or export the current session
`sticky` .....option for placing the widget in available space; valid choices are:
`N, NE, E, SE, S, SW, W, NW`
`padx` .....space used to pad the widget on the left and right
`pady` .....space used to pad the widget on the top and bottom

Example

```
window title="Widget = history"
history archive=TRUE
```



Label

Description

Creates a text label. If the `text` argument is left blank, `label` emulates the `null` widget.

Usage

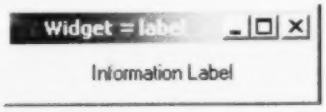
```
type= label text="" font="" fg="black" bg="" sticky="" padx=0
   pady=0
```

Arguments

`text` .....text to display in the label
`font` .....font for labels – specify family (`Times`, `Helvetica`, or `Courier`), size (as point size), and style (`bold`, `italic`, `underline`, `overstrike`), in any order
`fg` .....colour for label fonts
`bg` .....background colour for widget
`sticky` .....option for placing the widget in available space; valid choices are: `N`, `NE`, `E`, `SE`, `S`, `SW`, `W`, `NW`
`padx` .....space used to pad the widget on the left and right
`pady` .....space used to pad the widget on the top and bottom

Example

```
window title="Widget = label"
label text="Information Label"
```



Matrix

Description

An aligned set of entry fields for all components of a matrix. If the mode is logical, the matrix appears as a set of check boxes that can be turned on or off using mouse clicks.

Usage

```
type=matrix nrow ncol names rowlabels="" collabels=""
   rownames="" colnames="" font="" fg="black" bg=""
   entryfont="" entryfg="black" entrybg="white" values=""
   byrow=TRUE function="" enter=TRUE action="matrix"
   mode="numeric" width=6 sticky="" padx=0 pady=0
```

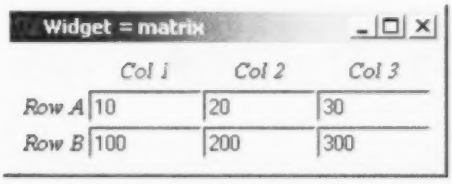
Arguments

`nrow` .....number of rows (required)
`ncol` .....number of columns(required)

`names`.....either one name or a set of `nrow*ncol` names used to store the matrix in R (required)
`rowlabels`.....either one label or a vector of `nrow` labels used to label rows of this matrix in the display
`collabels`.....either one label or a vector of `ncol` labels used to label columns of this matrix in the display
`rownames` .....string scalar or vector of length `nrow` to name the rows of the matrix
`colnames` .....string scalar or vector of length `ncol` to name the columns of the matrix
`font`.....font for labels – specify family (`Times`, `Helvetica`, or `Courier`), size (as point size), and style (`bold`, `italic`, `underline`, `overstrike`), in any order
`fg`.....colour for label fonts
`bg`.....background colour for widget
`entryfont`.....font of entries appearing in input/output boxes
`entryfg`.....font colour of entries appearing in input/output boxes
`entrybg`.....background colour of input/output boxes
`values` .....default values (either one value for all matrix components or a set of `nrow*ncol` values)
`byrow`.....if `TRUE` and `nrow*ncol` names are used, interpret the names by row; otherwise by column. Similarly, interpret `nrow*ncol` initial values.
`function` .....R function to call when any entry in the matrix is changed
`enter`.....if `TRUE`, call the function only after the <Enter> key is pressed
`action` .....string value associated whenever this widget is engaged
`mode`.....R mode for the matrix, where valid modes are: `numeric`, `integer`, `complex`, `logical`, `character`
`width`.....character width to reserve for the each entry in the matrix
`sticky` .....option for placing the widget in available space; valid choices are: `N`, `NE`, `E`, `SE`, `S`, `SW`, `W`, `NW`
`padx`.....space used to pad the widget on the left and right
`pady`.....space used to pad the widget on the top and bottom

Example

```
window title="Widget = matrix"
matrix nrow=2 ncol=3 rowlabels="'Row A' 'Row B'"
     collabels="'Col 1' 'Col 2' 'Col 3'" values="10 20 30 100
     200 300" names="a b c d e f" font="times 10 italic"
```



Menu

Description

A menu grouping. Submenus can either be `menu` or `menuitem`.

Usage

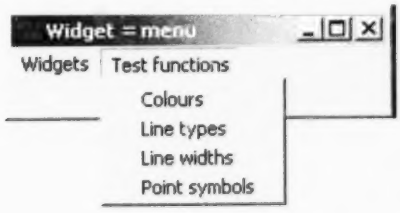
```
type=menu nitems=1 label font=""
```

Arguments

`nitems` .....number of items or submenus to include in the menu
`label`.....text to display as the menu label (required)
`font` .....font for labels – specify family (`Times`, `Helvetica`, or `Courier`), size (as point size), and style (`bold`, `italic`, `underline`, `overstrike`), in any order

Example (assuming that the R functions have been defined)

```
window title="Widget = menu"
menu nitems=1 label="Widgets"
     menuitem label="Show arguments" func=showArgs
menu nitems=4 label="Test functions"
     menuitem label="Colours" func=testCol
     menuitem label="Line types" func=testLty
     menuitem label="Line widths" func=testLwd
     menuitem label="Point symbols" func=testPch
```



MenuItem

Description

One of `nitems` following a `menu` command.

Usage

```
type=menuitem label font="" function action="menuitem"
```

Arguments

`label`.....text to display as the menu item label (required)
`font` .....font for labels – specify family (`Times`, `Helvetica`, or `Courier`), size (as point size), and style (`bold`, `italic`, `underline`, `overstrike`), in any order

`function` .....R function to call when the menu item is clicked (required)
`action` .....string value associated whenever this widget is engaged

Null

Description

Creates a null widget, useful for padding a grid with blank cells that appear as empty space.

Usage

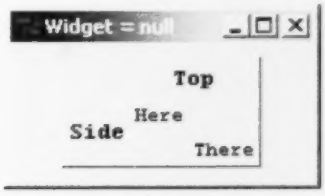
```
type=null padx=0 pady=0
```

Arguments

`padx` .....space used to pad the label on the left and right
`pady` .....space used to pad the label on the top and bottom

Example

```
grid 2 2 relief=raised toptitle=Top sidetitle=Side
     topfont="Courier 10 bold" sidefont="courier 10 bold"
     label text="Here" font="courier 8"
     null
     null
     label text="There" font="courier 8"
```



Object

Description

A widget that represents the R-object specified – a vector becomes a `vector` widget, a matrix becomes a `matrix` widget, and a data frame becomes a `data` widget. transpose

Usage

```
type=object name font="" fg="black" bg="" entryfont=""
  entryfg="black" entrybg="white" vertical=FALSE byrow=TRUE
  function="" enter=TRUE action="data" width=6 sticky=""
  padx=0 pady=0
```

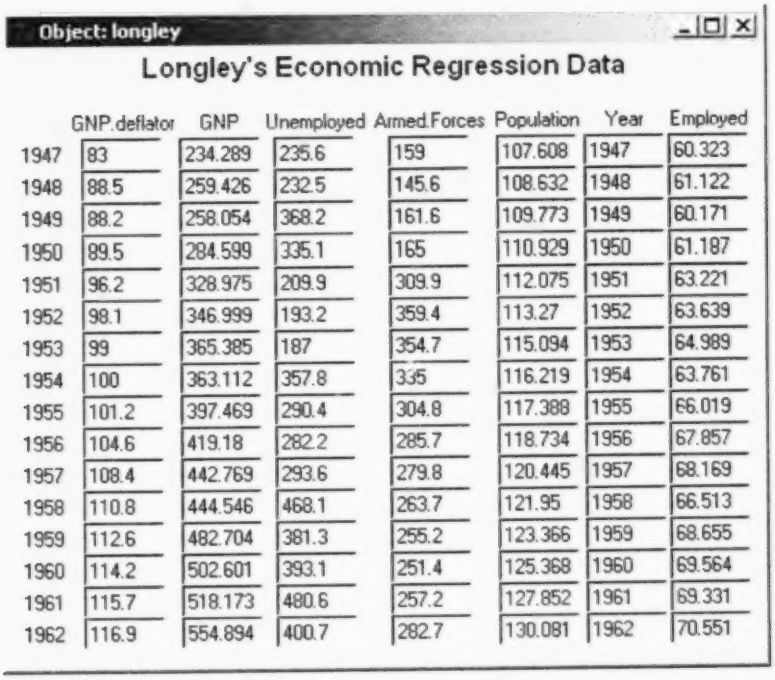
Arguments

`name` .....name of object (vector, matrix, or data frame) to convert to a widget (required)

`font` .....font for labels – specify family (`Times`, `Helvetica`, or `Courier`), size (as point size), and style (`bold`, `italic`, `underline`, `overstrike`), in any order
`fg`.....colour for label fonts
`bg`.....background colour for widget
`entryfont`.....font of entries appearing in input/output boxes
`entryfg`.....font colour of entries appearing in input/output boxes
`entrybg`.....background colour of input/output boxes
`vertical` .....if `TRUE` , display the vector as a vertical column with labels on the left; otherwise display it as a horizontal row with labels above
`function` .....R function to call when any entry in the vector is changed
`enter`.....if `TRUE`, call the function only after the <Enter> key is pressed
`action` .....string value associated whenever this widget is engaged
`width`.....character width to reserve for the each entry in the vector
`sticky` .....option for placing the widget in available space; valid choices are: `N`, `NE`, `E`, `SE`, `S`, `SW`, `W`, `NW`
`padx`.....space used to pad the widget on the left and right
`pady`.....space used to pad the widget on the top and bottom

Example

```
window bg="#ffd2a6" title="Object: longley"
label text="Longley\'s Economic Regression Data" font="bold
     12" fg="#400080" pady=0 sticky=S
object name=longley width=7 pady=5
```



	GNP.deflator	GNP	Unemployed	Armed.Forces	Population	Year	Employed
1947	83	234.289	235.6	159	107.608	1947	60.323
1948	88.5	259.426	232.5	145.6	108.632	1948	61.122
1949	88.2	258.054	368.2	161.6	109.773	1949	60.171
1950	89.5	284.599	335.1	165	110.929	1950	61.187
1951	96.2	328.975	209.9	309.9	112.075	1951	63.221
1952	98.1	346.999	193.2	359.4	113.27	1952	63.639
1953	99	365.385	187	354.7	115.094	1953	64.989
1954	100	363.112	357.8	335	116.219	1954	63.761
1955	101.2	397.469	290.4	304.8	117.388	1955	66.019
1956	104.6	419.18	282.2	285.7	118.734	1956	67.857
1957	108.4	442.769	293.6	279.8	120.445	1957	68.169
1958	110.8	444.546	468.1	263.7	121.95	1958	66.513
1959	112.6	482.704	381.3	255.2	123.366	1959	68.655
1960	114.2	502.601	393.1	251.4	125.368	1960	69.564
1961	115.7	518.173	480.6	257.2	127.852	1961	69.331
1962	116.9	554.894	400.7	282.7	130.081	1962	70.551

Radio

Description

One of a set of mutually exclusive radio buttons for making a particular choice. Buttons with the same value for `name` act collectively to define a single choice among the alternatives.

Usage

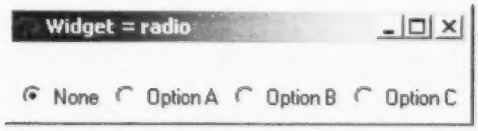
```
type= radio name value text="" font="" fg="black" bg=""
   function="" action="radio" mode="numeric" sticky="" padx=0
   pady=0
```

Arguments

`name` .....name of R variable altered by this radio button, where radio buttons with the same name define a mutually exclusive set (required)
`value` .....value of the variable when this radio button is selected (required)
`text` .....identifying text placed to the right of this radio button
`font` .....font for labels – specify family (`Times`, `Helvetica`, or `Courier`), size (as point size), and style (`bold`, `italic`, `underline`, `overstrike`), in any order
`fg` .....colour for label fonts
`bg` .....background colour for widget
`function` .....R function to call when this radio button is selected
`action` .....string value associated whenever this widget is engaged
`mode` .....R mode for the value associated with this button, where valid modes are: `numeric`, `integer`, `complex`, `logical`, `character`
`sticky` .....option for placing the widget in available space; valid choices are: `N`, `NE`, `E`, `SE`, `S`, `SW`, `W`, `NW`
`padx` .....space used to pad the widget on the left and right
`pady` .....space used to pad the widget on the top and bottom

Example

```
window title="Widget = radio"
grid 1 4
     radio name=junk value=0 text="None"
     radio name=junk value=1 text="Option A"
     radio name=junk value=2 text="Option B"
     radio name=junk value=3 text="Option C"
```



Slide

Description

A slide bar that sets the value of a variable. This widget only accepts integer values.

Usage

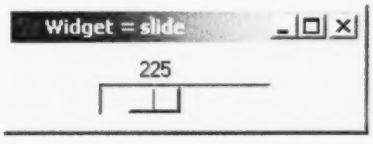
```
type= slide name from=0 to=100 value=NA showvalue=FALSE
  orientation="horizontal" font="" fg="black" bg=""
  function="" action="slide" sticky="" padx=0 pady=0
```

Arguments

`name` .....name of the numeric R variable corresponding to this slide bar (required)
`from` .....minimum value of the variable (must be an integer)
`to` .....maximum value of the variable (must be an integer)
`value` .....initial slide value, where the default is the specified `from` value
`showvalue` .....if `TRUE`, display the current slide value above the slide bar
`orientation` ...direction for orienting the slide bar: `horizontal` or `vertical`
`font` .....font for labels – specify family (`Times`, `Helvetica`, or `Courier`), size (as point size), and style (`bold`, `italic`, `underline`, `overstrike`), in any order
`fg` .....colour for label fonts
`bg` .....background colour for widget
`function` .....R function to call when the slide value is changed
`action` .....string value associated whenever this widget is engaged
`sticky` .....option for placing the widget in available space; valid choices are: `N`, `NE`, `E`, `SE`, `S`, `SW`, `W`, `NW`
`padx` .....space used to pad the widget on the left and right
`pady` .....space used to pad the widget on the top and bottom

Example

```
window title="Widget = slide"
slide name=junk from=1 to=1000 value=225 showvalue=T
```



SlidePlus

Description

An extended slide bar that also displays a minimum, maximum, and current value. This widget accepts real numbers.

Usage

```
type= slideplus name from=0 to=1 by=0.01 value=NA function=""
  enter=FALSE action="slideplus" sticky="" padx=0 pady=0
```

Arguments

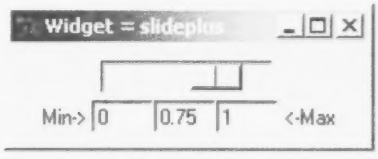
`name` .....name of the numeric R variable corresponding to this slide bar (required)
`from` .....minimum value of the variable
`to` .....maximum value of the variable
`by` .....minimum amount for changing the variable's value
`value` .....initial slide value, where the default is the specified `from` value
`function` .....R function to call when the slide value is changed
`enter` .....if `TRUE` and the slide value is changed via the entry box, call the function only after the <Enter> key is pressed
`action` .....string value associated whenever this widget is engaged
`sticky` .....option for placing the widget in available space; valid choices are: `N`, `NE`, `E`, `SE`, `S`, `SW`, `W`, `NW`
`padx` .....space used to pad the widget on the left and right
`pady` .....space used to pad the widget on the top and bottom

Note

To facilitate retrieving and setting the minimum and maximum values, two additional variables are created by suffixing "`.max`" and "`.min`" to the given `name`.

Example

```
window title="Widget = slideplus"
slideplus name=junk from=0 to=1 by=0.01 value=0.75
```



Text

Description

An information text box that can display messages, results, or whatever the user desires. The displayed information can be either fixed or editable.

Usage

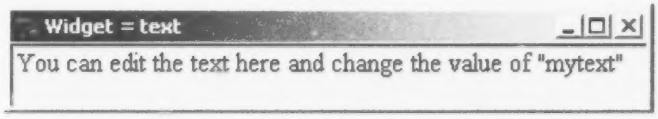
```
type= text name height=8 width=30 edit=FALSE fg="black"
  bg="white" mode="character" font="" value="" borderwidth=1
  relief="sunken" edit=TRUE padx=0 pady=0
```

Arguments

`name` .....name of the R variable containing the text (required)
`height` .....text box height
`width`.....text box width
`edit` .....if `TRUE`, the user can edit the value stored in `name`
`fg`.....colour for label fonts
`bg`.....background colour specified in hexadecimal format; e.g., `rgb(255,209,143,maxColorValue=255)` yields `"#FFD18F"`
`mode`.....R mode for the value associated with this widget, where valid modes are: `numeric`, `integer`, `complex`, `logical`, `character`
`font`.....font for labels – specify family (`Times`, `Helvetica`, or `Courier`), size (as point size), and style (`bold`, `italic`, `underline`, `overstrike`), in any order
`value`.....default value to display in the text
`borderwidth`...width of the border around the text box
`relief` .....type of border around the text, where valid styles are: `raised`, `sunken`, `flat`, `ridge`, `groove`, `solid`
`edit`.....if `TRUE`, allow user to edit the contents of the text box
`padx`.....space used to pad the widget on the left and right
`pady`.....space used to pad the widget on the top and bottom

Example

```
window title="Widget = text"
text name=mytext height=2 width=55 bg="#FFD18F" \
     font="times 11" borderwidth=1 relief="sunken" edit=TRUE \
     value="You can edit the text here and change the value of
     \"mytext\""
```



Vector

Description

An aligned set of entry fields for all components of a vector. If the mode is logical, the vector appears as a set of check boxes that can be turned on or off using mouse clicks.

Usage

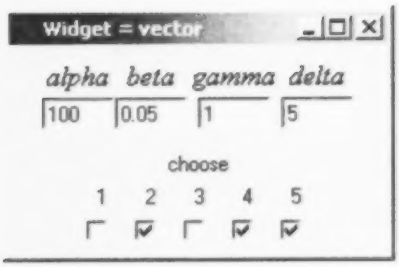
```
type=vector names length=0 labels="" values="" vecnames=""
  font="" fg="black" bg="" entryfont="" entryfg="black"
  entrybg="white" vertical=FALSE function="" enter=TRUE
  action="vector" mode="numeric" width=6 sticky="" padx=0
  pady=0
```

Arguments

`names`.....either one name (for a whole vector) or a vector of names for individual variables used to store the values in R (required)
`length`.....required only if a single name is given for a vector of length greater than 1
`labels`.....labels for the vector display – either one label, a vector of `length` labels, or `NULL` for no labels (default `""` labels with `names` and, if number of specified `names` is one, numbered elements)
`values`.....default values (either one value for all vector components or a vector of `length` values)
`vecnames`.....string vector of length `length` to name the scalars or vector
`font`.....font for labels – specify family (`Times`, `Helvetica`, or `Courier`), size (as point size), and style (`bold`, `italic`, `underline`, `overstrike`), in any order
`fg`.....colour for label fonts
`bg`.....background colour for widget
`entryfont`.....font of entries appearing in input/output boxes
`entryfg`.....font colour of entries appearing in input/output boxes
`entrybg`.....background colour of input/output boxes
`vertical`.....if `TRUE` , display the vector as a vertical column with labels on the left; otherwise display it as a horizontal row with labels above
`function`.....R function to call when any entry in the vector is changed
`enter`.....if `TRUE`, call the function only after the <Enter> key is pressed
`action`.....string value associated whenever this widget is engaged
`mode`.....R mode for the vector, where valid modes are: `numeric`, `integer`, `complex`, `logical`, `character`
`width`.....character width to reserve for the each entry in the vector
`sticky`.....option for placing the widget in available space; valid choices are: `N`, `NE`, `E`, `SE`, `S`, `SW`, `W`, `NW`
`padx`.....space used to pad the widget on the left and right
`pady`.....space used to pad the widget on the top and bottom

Example

```
window title="Widget = vector"
vector length=4 names="a b g d" labels="alpha beta gamma
     delta" values="100 0.05 1 5" font="times italic" width=6
vector length=5 mode=logical names=chosen labels=choose
     values="F T F T T"
```



Window

Description

Create a new window. Windows are used as a palette upon which widgets are placed. Each open window has a unique name. The function `closeWin` closes all windows unless a specific name (or vector of names) is provided by the user. Also, if `createWin` opens a window with a name already in use, the older window is closed before the new window is opened.

Usage

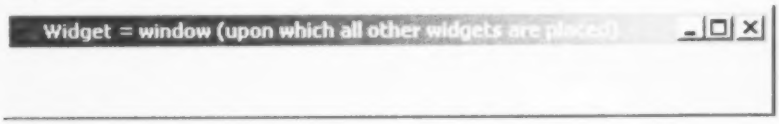
```
type=window name="window" title="" vertical=TRUE bg="#D4D0C8"
   fg="#000000" onclose=""
```

Arguments

`name` .....unique name identifying an open window
`title`.....text to display in the window's title line
`vertical` .....if `TRUE`, arrange widgets vertically, top to bottom, within the window
`bg`.....background colour for window
`fg`.....colour for label fonts
`onclose`.....name of function called when user closes the window by pressing

Example

```
window title="Widget = window (upon which all other widgets
     are placed)"
```



Appendix B. Building `PBSmodelling` and other packages

The R project defines a standard for creating a package of functions, data, and documentation. You can obtain a comprehensive guide to "Writing R Extensions" (R Development Core Team 2006b, `R-exts.pdf`) from the CRAN web site or the R GUI (see the References above). Ligges (2003) and Ligges and Murdoch (2005) provide useful introductions. We have designed `PBSmodelling` and a very simple enclosed package `PBStry` as prototypes for package development. This Appendix summarizes the steps needed to:

B.1. install the required software;
B.2. build PBS Modelling from source materials;
B.3. write source materials for a new package and compile them;
B.4. include C code in a package.

Our discussion applies only to package development on a computer running Microsoft Windows 2000, XP, or (maybe) later. We particularly highlight issues that have proved troublesome for us. The R `library` directory `PBSmodelling\PBStools` contains batch files that can assist the process. For example, you might locate this directory as `C:\Utils\R\R-2.4.1\library\PBSmodelling\PBStools`.

B.1. Installing required software

Building R packages requires six pieces of free software. Even if some of this software is already installed, it may be helpful (or even essential) to update to the latest versions. We recommend installing each package on a path that does *not* include spaces. For example, avoid using `C:\Program Files`, even if that happens to be part of a package's default path. In this appendix, we use `C:\Utils` as a root directory for all required software. The list below shows versions available at the time of writing this report, along with suggested paths.

1. **R** itself, currently version 2.4.1 (`C:\Utils\R\R-2.4.1`). We assume that R is already installed from the CRAN web site http://cran.r-project.org/ and that it runs correctly on your computer. We also assume that the package `PBSmodelling` is installed in R.
2. A set of **UNIX tools** for building R packages in Windows, currently with no version number (`C:\Utils\Rtools`). Obtain the file `tools.zip` from the web site http://www.murdoch-sutherland.com/Rtools/. Uncompress this file in `C:\Utils`, and (if you wish) rename the base directory from `\tools` to `\Rtools`. It should contain the subdirectory `\bin`. These tools are *essential*. DO NOT plan to use programs with the same name in an installation of Cygwin or any other UNIX emulator that happens to be installed on your computer.
3. **Perl**, currently version 5.8.8.817 (`C:\Utils\Perl`). Obtain this from the Active State web site: http://www.activestate.com/Products/ActivePerl/Download.html.
4. **MinGW**, currently version 5.0.3 (`C:\Utils\MinGW`), the minimalist GNU C compiler for Windows. Obtain a small installation file from http://www.mingw.org/, and use this as a package manager to download and install at least the basic components.

Alternatively, you may wish to obtain **Dev-C++**, currently version 4.9.9.2 (`C:\Utils\DevCpp`). Obtain a complete installation file from http://www.bloodshed.net/. This package includes a distribution of MinGW and a convenient integrated development environment (IDE) for compiling and testing C programs. Based on our current experience, Dev-C++ works as an adequate substitute for MinGW in building R packages.

5. **MiKTeX**, currently version 2.5 (`C:\Utils\MiKTeX`), available from http://www.miktex.org/. This processor for TeX and LaTeX files helps typeset help files within a package. If you don't have version 2.5 or later, take this opportunity to upgrade. Download the "basic" installation file, and install these components only. You can add more LaTeX packages from the Internet later, as required. (MiKTeX often does this automatically.) Take some time to investigate the MiKTeX package manager (`mpm.exe` or go to the "Programs" menu and select "MiKTeX 2.5", "Browse Packages").

   We recommend enhancing MiKTeX slightly, so that it can independently process the LaTeX files produced from R documentation files. The installation has a directory for storing LaTeX styles and font definitions (`C:\Utils\MiKTeX\tex\latex` in the present context). Subdirectories contain the necessary files; for example `\ae` defines "almost European" fonts. Create the new subdirectory `\R`, and copy into it all files from `\texmf` in the R installation tree (e.g., `C:\WinApps\R\R-2.4.1\share\texmf`). These should include `Rd.sty`. Next, go to the "Start" menu, select "Programs" then "MiKTeX 2.5", and run the program "Settings". In the "General" tab, click the button marked "Refresh FNDB". This refreshes MiKTeX's file name database, so that it recognizes files in the new `\R` subdirectory.

   The text editor **WinEdt** (available from http://www.winedt.com/) provides a convenient GUI for editing LaTeX files and operating MiKTeX. Combined with the R package `RWinEdt`, it can also serve as an editor and interface for R. However, it is available only as shareware that requires a fee for long-term use, unlike any other software mentioned here.

6. The Microsoft **HTML Help Workshop** (no version shown, `C:\Utils\HHW`). You need the installation file `HtmlHelp.exe`, currently at
   http://www.microsoft.com/office/ork/xp/appndx/appa06.htm.
   If Microsoft no longer makes it available there, you can obtain the file from http://www.murdoch-sutherland.com/Rtools/. After installation, we think you can safely ignore a message that "This computer already has a newer version of HTML Help". (If anyone has different information, please let us know.)

After these six pieces of software are installed, you're ready to start building R packages. For this purpose, create a new directory that can contain your packages; such as `D:\Rdevel\`. Within the R library directory, which could be `C:\Utils\R\R-2.4.1\library\`, find the subdirectory `PBSmodelling\PBStools`. Copy all the batch files there into your new packages directory. You should have these 11 files:

- `definePaths.bat`, `checkPaths.bat` related to the installation;
- `checkPBS.bat`, `buildPBS.bat`, `packPBS.bat`, `unpackPBS.bat` related to *PBS Modelling*;

- `check.bat`, `build.bat`, `pack.bat`, `unpack.bat`, `makePDF.bat` related to the construction of new packages.

You need to change `definePaths.bat` so that it reflects the paths you chose in the above six installations. For example, your version of this batch file might contain the lines

```
set R_PATH=C:\Utils\R\R-2.4.1\bin
set TOOLS_PATH=C:\Utils\Rtools\bin
set PERL_PATH=C:\Utils\Perl\bin
set MINGW_PATH=C:\Utils\MinGW\bin
set TEX_PATH=C:\Utils\MiKTeX\miktex\bin
set HTMLHELP_PATH=C:\Utils\HHW
```

Notice that each path, except the last, ends in a `bin` subdirectory.

Hopefully, your installation is now complete. In your new packages directory, run `checkPaths.bat` from a command line or double-click the icon. This script verifies that a few essential files lie on the indicated paths. If everything is correct, you should see the message "All program paths look good". Otherwise, you'll see a warning about software that doesn't appear on your specified paths.

You may wish to inspect all the batch files with a text editor. They don't use your system PATH environment variable. Instead, each one defines a new local path appropriate for building R packages (via `checkPaths.bat`). A `SETLOCAL` command ensures that this change doesn't alter your system's permanent environment.

B.2. Building `PBSmodelling`

Once all the required software is installed, the batch files discussed above make it fairly easy to build `PBSmodelling`. We assume that you have already created the directory discussed in Appendix B.1, say `D:\Rdevel`, for building R packages and that it contains the relevant eight batch files. In particular, `definePaths.bat` should reflect your installation paths and `checkPaths.bat` should report the message that "All program paths look good". Then follow these steps:

1. On the CRAN web site http://cran.r-project.org/, go to "Packages" on the left and find `PBSmodelling`. Download the file `PBSmodelling_x.xx.tar.gz` into `D:\Rdevel`. Then rename this file (or copy it and rename the copy) so that the version number is removed. You should now have the file `PBSmodelling.tar.gz` in `D:\Rdevel`.
2. In the development directory `D:\Rdevel`, double-click the icon for `unpackPBS.bat` or type the command `unpackPBS` in a corresponding command window. This should extract the contents of `PBSmodelling.tar.gz`, preserving directory structure, into a subdirectory `\PBSmodelling` with five sudirectories: `\data`, `\inst`, `\man`, `\R`, and `\src`.
3. Our batch file uses the command `tar -xzvf PBSmodelling.tar.gz`, where `tar.exe` appears in the `\Rtools` directory (section B.1, step 2). The command line

parameters specify a verbose (v) extraction (x) of the given file (f), after filtering with gzip (z).

If you use other software for this extraction, please ensure that it is configured to handle UNIX files correctly. For example, "WinZip" has an option to extract a "TAR file with smart CR/LF conversion". This must be turned off.

4. In the base directory D:\Rdevel, double-click the icon for checkPBS.bat or type the command checkPBS in a corresponding command window. If all software is installed correctly and D:\Rdevel\PBSmodelling correctly represents the contents of the .tar.gz file, you should see a series of DOS messages reporting "OK" to various tests. A distinct pause might accompany the message: "checking whether package 'PBSmodelling' can be installed ...".
5. You might also encounter a delay as MiKTeX downloads the LaTeX package lmodern, part of a larger package lm. If this is really slow, you can abort the process and install lm with the MiKTeX package manager, as discussed in step 5 of section B.1. Choose a remote server near you. You only need to do this once. When it's finished, run checkPBS.bat again.
6. Examine the new directory D:\Rdevel\PBSmodelling.Rcheck created by the check process in step 2. The text files 00check.log and 00install.out show detailed results.
7. In the base directory D:\Rdevel, double-click the icon for buildPBS.bat or type the command buildPBS in a corresponding command window. This creates the file D:\Rdevel\PBSmodelling.zip, which could be used to install PBSmodelling from a local zip file.
8. Again in the base directory D:\Rdevel, double-click the icon for packagePBS.bat or type the command packagePBS in a corresponding command window. This creates a new package distribution file PBSmodelling_x.xx.tar.gz that replaces the one downloaded from CRAN in step 1.
9. Finally, type the command makePDF PBSmodelling in a command window for D:\Rdevel. This generates an indexed documentation file PBSmodelling.pdf for the package, and it also produces a subdirectory .Rd2dvi that contains the LaTeX version of this file: Rd2.tex. See Appendix C.3 for further details about the use of this file for producing this report.

If these steps all work without problems, you can be pretty sure that the requisite software is installed correctly and that you understand the basic steps needed to build R packages.

B.3. Creating a new R package

R packages require a special directory structure. The R function package.skeleton automatically creates this structure, but (without further work) it does not produce a package that can be compiled. Although PBSmodelling has the requisite structure, it is perhaps too complicated to serve as a convenient prototype. For this reason, we include a small subset

PBStry that illustrates the key details. You can make a new package simply by editing the files in PBStry. You need a suitable editor (e.g., WinEdt or the Notepad) to view and change various text files.

1. Start by locating the file PBStry_x.xx.tar.gz in the R library directory \PBSmodelling\PBStools. Copy this file into your development directory, such as D:\Rdevel, and rename it (or copy and rename the copy) to obtain the file PBStry.tar.gz.

2. Remove any previous traces of PBStry in your development directory, such as subdirectories PBStry, PBStry.Rcheck, and .Rd2dvi, along with the documentation file PBStry.pdf.

3. Follow steps similar to those in section B.2 to unpack, check, build, re-package, and document PBStry. You must now use a DOS command window in D:\Rdevel to issue the five commands
```
unpack PBStry
check PBStry
build PBStry
pack PBStry
makePDF PBStry
```
which invoke the batch files unpack.bat, check.bat, build.bat, pack.bat and makePDF.bat. The first command should give you a new subdirectory \PBStry, along with its five sudirectories: \data, \inst, \man, \R, and \src.

4. Use your editor to open the file DESCRIPTION in the root directory \PBStry. This file, essential in every R package, contains key information in a special format (RDCT 2006b, section 1.1.1). The following example illustrates a minimal set of required fields.

5.
```
Package: MyPack
Version: 1.00
Date: 2006-12-31
Title: My R Package
Author: User of PBS Modelling
Maintainer: User of PBS Modelling
Depends: R (>= 2.3.0)
Description: My customized R functions
License: GPL version 2 or newer (recommended)
```

6. The package name in DESCRIPTION must agree with the directory name in which this file lies. For example, if you change PBStry to MyPack in DESCRIPTION and rename the directory from \PBStry to \MyPack, you have effectively changed the package name. Similarly, if you change the version to 1.01, you have effectively changed the version number that appears in the file names for distributing your package.

7. The subdirectory \PBStry\R contains all R code used by the package. For example, PBStry includes seven R functions (calcFib, calcFib2, calcGM, calcSum, findPat, pause, and view). The seven files could be combined into a single file (such as PBStry.R), but we use separate files here for clarity. The functions all have relatively

simple code, hopefully comprehensible to users with limited R experience. Five of them come from PBSmodelling. Three of them (calcFib, calcFib2, calcSum) call compiled C code, as we discuss more completely in section B.4 below.

8. By convention, the distinct file zzz.R defines code for initializing the package. In this case the function .First.lib, calls library.dynam to load a dynamic link library (PBStry.dll) created from compiled C code during the build process.

9. When a version number changes, the DESCRIPTION file must be changed accordingly. We also like to make a corresponding change in zzz.R, so that the version number appears on the R console when the library is loaded. PBStry illustrates this possibility for zzz.R.

10. The subdirectory \PBStry\data contains all data objects that come with the package. Here, the binary file QBR.rda holds a matrix of quillback rockfish (*Sebastes maliger*) sample data used in the CCA example above (section 5.2.3). The same data matrix is called CCA.qbr.hl in PBSmodelling.

11. If you want to add data to a new package, first create the object (e.g., myData) in R and then execute the command:
    `save(myData,file="myData.rda")`
    The object name must match the prefix in the file name, and the suffix must be .rda. Include the resulting file in your package's \data subdirectory.

12. The subdirectory \PBStry\man contains a documentation file for every object in the package. PBStry has six functions and one data set, so the \man subdirectory has seven corresponding R documentation files (*.Rd). An additional file PBStry.Rd documents the package as a whole. Rd files use a rather complex scripting language (RDCT 2006b, section 2) that can be converted to help files in several formats (PDF, HTML, text). For many packages, the examples in PBStry may provide adequate prototypes. They represent three distinct cases: functions (e.g., calcGM.Rd, findPat.Rd), data sets (QBR.Rd), and complete packages (PBStry.Rd).

13. The subdirectory \PBStry\src contains source code for C code to be compiled into the dynamic link library PBStry.dll. We include sample files to calculate Fibonacci numbers iteratively (fib.c, fib2.c) and to add the components of a numeric vector (sum.c). In section B.4, we discuss the linkage between R code and compiled C functions.

14. Finally, the subdirectory \PBStry\inst contains files that are to be included directly in the R library tree for PBStry when the package is installed. The file PBStry-Info.txt briefly describes the context and purpose of the trial package.

If you have successfully followed the steps above, you have actually built two R packages, PBSmodelling and PBStry. Furthermore, you're reasonably familiar with the contents of PBStry. You can use the files in that small package as prototypes for writing your own R package, which might contain R code in the subdirectory \R, data in \data, C source code in \src, and R documentation in \man.

The larger package PBSmodelling offers more prototypes and uses a somewhat different style. The main directory includes the required DESCRIPTION file, plus a second file NAMESPACE that lists all objects available to a user of the package. Effectively, the namespace mechanism distinguishes between objects provided by the package and other (hidden) objects required for the implementation, but not intended for public use. Our NAMESPACE file contains the rather cryptic instruction: exportPattern("^[^\\.]"). The R string "^[^\\.]" translates to the regular expression ^[^\.] that designates any pattern not starting with a period (.). We don't export "dot" objects, whose names in R start with a period. (For more complete information, see the file PBSMfunctions.txt in the subdirectory \inst or the R library directory for PBSmodelling.) The namespace file must also import functions required from other packages. Because PBSmodelling relies on tcltk, the file includes the command: import(tcltk).

In PBStry, without a namespace, the file zzz.R defines the initializing function .First.lib, as mentioned in step 4 above. By contrast, the namespace protocol in PBSmodelling requires a different name for the initializing function: .onLoad in zzz.R.

In summary, we recommend building a new package by editing, adding, and deleting prototype files in PBStry. Our batch files can facilitate tests and debugging. For more advanced work, particularly packages with a namespace protocol, look at PBSmodelling. Have a current version of RDCT (2006b) available, and consult that manual when necessary. We find it useful to keep the PDF file open and to use Acrobat's search feature (Ctrl-F) to find topics of interest.

B.4. Embedding C code

R provides two functions, .C() and .Call(), for invoking compiled C code. PBStry includes two simple examples that use .C(), probably the method of choice for simple packages. The .Call() function uses a more complex interface that offers better support for R objects, and another example illustrate that calling convention.

Table B1. C representations of R data types.

R Object	C Type
logical	int *
integer	int *
double	double *
complex	Rcomplex * [1]
character	char **

[1] Rcomplex is defined in Complex.h.

Calling C functions from R using `.C()`

The `.C()` calling convention uses the following key concepts:

- R must allocate the appropriate length and type of variables before calling a C function.
- R objects are transformed into an equivalent C type (Table B.1), and a pointer to the value is passed into the C function. All values are returned by modifying the original values passed in.
- A C function called by `.C()` must have return type `void`, because values are returned only by accessing the predefined R function arguments.
- C code written for the shared DLL must not contain a `main` function.
- Within a C function, dynamically allocated memory must be de-allocated by the programmer before the function returns. Otherwise a memory leak will likely occur.
- `.C()` returns a list similar to the '...' list of arguments passed in, but reflecting any changes made by the C code. (See the help file for `.C`)

Table B2. Two text files associated with a `.C()` call in `PBStry`. R code in the first file calls C code in the second.

File 1: calcFib.R

```
calcFib <- function(n, len=1) {
  if (n<0) return(NA);
  if (len>n) len <- n;
  retArr <- numeric(len);
  out <- .C("fibonacci", as.integer(n), as.integer(len),
            as.numeric(retArr), PACKAGE="PBStry")
  x <- out[[3]]
  return(x) }
```

File 2: fib.c

```
void fibonacci(int *n, int *len, double *retArr) {
  double xa=0, xb=1, xn=-1; int i,j;
  /* iterative loop */
  for(i=0;i<=*n;i++) {
    /* initial conditions: fib(0)=0, fib(1)=1 */
    if (i <= 1) { xn = i; }
    /* fib(n) = fib(n-1) + fib(n-2) */
    else {xn = xa + xb; xa = xb; xb = xn; }
    /* save results if iteration i is within the
       range from n-len to n */
    j = i - *n + *len - 1;
    if (j >= 0) retArr[j] = xn;
  } /* end loop */
} /* end function */
```

The function `calcFib` in `PBStry` illustrates an application of these concepts (Table B2). The R function uses C code to calculate the first `n` Fibonacci numbers iteratively, where a vector holds the last `len` numbers calculated. After ensuring that `n` and `len` satisfy obvious constraints, the R code creates a return array `retArr` of the appropriate length. The `.C`

call passes n, `len`, and `retArr` by reference to the C function `fibonacci`. On exit, the vector `out` contains a list corresponding to the input variables n, `len`, and `retArr`, so that the third component `out[[3]]` holds the modified vector of values calculated by `fibonacci`. We encourage you also to examine a second example in `PBStry`, associated the files `calcSum.R` and `sum.c`.

Table B3. `.Call()` example adapted from `PBStry`, with two associated text files. R code in the first file calls C code in the second.

File 1: calcFib2.R

```
calcFib2 <- function(n, len=1) {
  out <- .Call("fibonacci2", as.integer(n),
               as.integer(len), PACKAGE="PBSmodelling")
  return(out) }
```

File 2: fib2.c

```
#include <R.h>
#include <Rdefines.h>
SEXP fibonacci2(SEXP sexp_n, SEXP sexp_len) {
  /* ptr to output vector that we will create */
  SEXP retVals;
  double *p_retVals, xa=0, xb=1, xn;
  int n, len, i, j;
  /* convert R variables into C 'int's */
  len = INTEGER_VALUE(sexp_len);
  n = INTEGER_VALUE(sexp_n);
  /* Allocate space for the output vector */
  PROTECT(retVals = NEW_NUMERIC(len));
  p_retVals = NUMERIC_POINTER(retVals);
  /* iterative loop */
  for(i=0; i<=n; i++) {
    /* initial conditions: fib(0)=0, fib(1)=1 */
    if (i <= 1) { xn = i; }
    /* fib(n) = fib(n-1) + fib(n-2) */
    else { xn = xa + xb; xa = xb; xb = xn; }
    /* save results if iteration i is within the
       range from n-len to n */
    j = i - n + len - 1;
    if (j >= 0) p_retVals[j] = xn;
  } /* end loop */
  UNPROTECT(1);
  return retVals;
} /* end fibonacci2 */
```

Calling C functions from R using `.Call()`

The `.C()` convention requires a fairly simple conversion of R objects into C types (Table B.1). By contrast, `.Call()` provides extra structure that enables C to handle R objects directly (RDCT 2006b, section 4.7). This function uses "S-expression" `SEXP` types defined in `rinternals.h`., a file in the `\include` directory of the R installation. An `SEXP` pointer can reference any type of R object. The `.Call()` convention uses the following key concepts:

- C functions called by R must accept only `SEXP` typed arguments. These arguments should be treated as read only.
- Similarly, C functions called by R must have `SEXP` return types.
- The Programmer must protect R objects from the R garbage collector, and must release protected objects before the function terminates. R provides macros for this task.
- C code written for the shared DLL must not contain a `main` function.
- Within a C function, dynamically allocated memory must be de-allocated by the programmer before the function returns. Otherwise a memory leak will likely occur.

The function `calcFib2` in Table B3 illustrates an application of these concepts. As before, the R function uses C code to calculate the first `n` Fibonacci numbers iteratively, where a vector holds the last `len` numbers calculated. (To save space, we've removed R code that checks constraints on `n` and `len`). The simple `.Call` to `fibonacci2` looks very natural. Input values `n` and `len` produce the output vector `out`, where the C code must somehow determine what `out` should be. Not surprisingly, it requires more complicated C code to make this happen.

The C function `fibonacci2` (Table B3) first loads header files that include the required definitions from R. All input and output variables belong to type `SEXP`. Other internal variables have the standard C types `double` and `int`. Functions like `INTEGER_VALUE()` convert R types into C types. The `SEXP` vector `retVals` of return values is created by the R constructor `NEW_NUMERIC()` and then protected from garbage collection by `PROTECT()`. After all required variables are defined and type cast correctly, the iterative loop of calculations follows the earlier example in Table B2. Finally, the only protected vector `retVals` is released by `UNPROTECT(1)`, and the standard closing command `return retVals` returns the output vector from `fibonacci2`.

Obviously, it takes some time and effort to become familiar with the specialized R types, constructors, and conversion functions. For this reason, it's probably easier at first to use `.C()`, rather than `.Call()`.

Appendix C. *PBS Modelling* functions and data

This appendix documents the objects currently made available by *PBS Modelling*, along with a list of function dependencies for exported functions and hidden "dot" functions. For more information about the hidden functions, see the file `PBSMfunctions.txt` in the R library directory for `PBSmodelling`. The final section shows the standard R manual for *PBS Modelling*, including help pages for all objects, a table of contents, and an index.

C.1. Objects in *PBS Modelling*

`addArrows`	Add arrows to a plot using relative (0:1) coordinates
`addLabel`	Add a label to a plot using relative (0:1) coordinates
`addLegend`	Add a legend to a plot using relative (0:1) coordinates
`addPBShistory`	Add current window settings to the current history record
`backPBShistory`	Move back one step in the saved values for a history widget
`calcFib`	Calculate Fibonacci numbers by several methods
`calcGM`	Calculate the geometric mean, allowing for zeroes
`calcMin`	Calculate the minimum of user-defined function
`CCA.qbr`	Dataset: sampled counts of quillback rockfish (*Sebastes maliger*)
`clearAll`	Remove all R objects from the global environment
`clearPBShistory`	Clear saved values for a history widget
`clearWinVal`	Remove all current widget variables
`closeWin`	Close GUI window(s)
`compileDescription`	Convert and save a window description as a list
`createVector`	Create a GUI with a `vector` widget
`createWin`	Create a GUI window
`drawBars`	Draw a linear barplot on the current plot
`expandGraph`	Expand the plot area by adjusting margins
`exportPBShistory`	Export a saved history
`findPat`	Search a character vector to find multiple patterns
`focusWin`	Set the focus on a particular window
`forwPBShistory`	Move forward one step in the saved values for a history widget
`genMatrix`	Generate test matrices for `plotBubbles`
`getPBSext`	Get a command associated with a filename
`getPBSoptions`	Retrieve a user option
`getWinAct`	Retrieve the last window action
`getWinFun`	Retrieve names of functions referenced in a window
`getWinVal`	Retrieve widget values for use in R code
`GT0`	Restrict a numeric variable to a positive value
`importPBShistory`	Import a history list from a file
`initPBShistory`	Create structures for a new `history` widget
`jumpPBShistory`	Jump to a particular history record
`openFile`	Open a file with the associated program
`pad0`	Pad numbers with leading zeroes

`parseWinFile`	Convert a window description file into a list object
`pause`	Pause between graphics displays or other calculations
`pickCol`	Pick a colour from a palette and get the hexadecimal code
`plotACF`	Plot autocorrelation bars from a data frame, matrix, or vector
`plotAsp`	Construct a plot with a specified aspect ratio
`plotBubbles`	Construct a bubble plot from a matrix
`plotCsum`	Plot cumulative sum of data
`plotDens`	Plot density curves from a data frame, matrix, or vector
`plotTrace`	Plot trace lines from a data frame, matrix, or vector
`promptOpenFile`	Display an "Open File" dialogue
`promptSaveFile`	Display a "Save File" dialogue
`readList`	Read a `list` from a file in *PBS Modelling* format
`resetGraph`	Reset `par` values for a plot
`restorePar`	Get actual parameters from scaled values
`runExamples`	Run GUI examples included with *PBS Modelling*
`scalePar`	Scale parameters to [0,1]
`setPBSext`	Set a command associated with a filename extension
`setPBSoptions`	Set a user option
`setWinAct`	Add a window action to the saved action vector
`setWinVal`	Update widget values
`show0`	Convert numbers into text with specified decimal places
`showArgs`	Display expected widget arguments
`testCol`	Display named colours available based on a set of strings
`testLty`	Display line types available
`testLwd`	Display line widths
`testPch`	Display plotting symbols and backslash characters
`testWidgets`	Display sample GUIs and their source code
`unpackList`	Unpack `list` elements into variables
`vbdata`	Dataset: Length-at-age data for a von Bertalanffy curve
`vbpars`	Dataset: Initial parameters for a von Bertalanffy curve
`view`	Display first *n* rows of an object
`writeList`	Write a `list` to a file in *PBS Modelling* format

Dot functions (and two list objects: `.pFormatDefs` and `.widgetDefs`)

`.addslashes`	Escape special characters from a string
`.autoConvertMode`	Convert x into a numeric mode
`.buildgrid`	Attach child widgets to a grid
`.catError`	Display parsing errors
`.catError2`	Display parsing error (from C code)
`.convertMatrixListToDataFrame`	Convert a list into a data frame
`.convertMatrixListToMatrix`	Convert a list to a matrix (or a higher dimensional array)
`.convertMode`	Convert a variable into a mode without showing any warnings
`.convertPararmStrToList`	Convert a string representing a widget into a vector
`.convertPararmStrToVector`	Convert a string representing data into a vector
`.convertVecToArray`	Convert a vector to an array
`.createTkFont`	Creates a usable TK font from a given string
`.createWidget`	Call the appropriate sub-function (below) to create a given widget
`.createWidget.grid`	
`.createWidget.check`	
`.createWidget.label`	
`.createWidget.null`	
`.createWidget.matrix`	
`.createWidget.vector`	
`.createWidget.data`	
`.createWidget.object`	
`.createWidget.entry`	
`.createWidget.radio`	
`.createWidget.slide`	
`.createWidget.slideplus`	
`.createWidget.button`	
`.createWidget.text`	
`.createWidget.history`	
`.extractData`	Receive events from TK, and extract data for `getWinAct`
`.extractFuns`	Extract a list of called functions
`.extractVar`	Extract values from the `tclvar ptrs` of a window
`.fibC`	Call Fibonacci C code via `C`
`.fibCall`	Call Fibonacci C code via `Call`
`.fibClosedForm`	Close form equation for Fibonacci numbers
`.fibR`	Calculate Fibonacci numbers in R using iteration
`.getArrayPts`	Return all possible indices of an array
`.getMatrixListSize`	Determine the minimum required size of the required array
`.getParamFromStr`	Convert a string representing a widget into a list including default values as defined in `widgetDefs.r`

`.inCollection`	Find a needle in a haystack (may be removed in future)
`.initPBSoptions`	Initialization function when `PBSmodelling` is loaded
`.isReallyNull`	Test if a key exists in a list
`.map.add`	Save a new value for a given key, if no current value is set
`.map.get`	Returns a value associated with a key
`.map.getAll`	Return all values of the map
`.map.init`	Initialize the data structure that holds the map(s); a map is another name for hash table (implemented using an R list)
`.map.set`	Save a value, even if a current one exists
`.mapArrayToVec`	Determine the index to use for a vector, given the indices for an element of a higher dimensional array
`.matrixHelp`	Store an element in matrix list (or a higher dimensional array list)
`.parsegrid`	Create a branch in the parse tree for children widgets of a grid
`.parsemenu`	Create a branch in the parse tree for children widgets of a menu
`.PBSdimnameHelper`	Add `dimnames` to an object
`.pFormatDefs`	A list defining accepted parameters (and default values) for `"P"` format of `readList` and `writeList`
`.readList.P`	Read a list in `P` format
`.readList.P.convertData`	Convert data into a proper mode
`.searchCollection`	Search a haystack for a needle, or a similar longer needle
`.setMatrixElement`	Assign values from a list into a matrix (or a higher dimensional array)
`.setWinValHelper`	Update widget values when `setWinVal` is called
`.stopWidget`	Display fatal post-parsing errors and halt
`.stripComments`	Remove comments from a string
`.stripSlashes`	Removes escape backslashes from a string
`.stripSlashesVec`	Convert a grouping of strings representing an argument into a vector of strings
`.trimWhiteSpace`	Remove leading and trailing white space
`.updatePBShistory`	Update widget values
`.validateWindowDescList`	Check for a valid *PBS Modelling* description list and set any missing default values
`.validateWindowDescWidgets`	Validate a single widget
`.widgetDefs`	A list defining widget parameters and default values
`.writeList.P`	Saves a list to disk using the `"P"` format

C.2. Function dependencies

This appendix documents function dependencies within *PBS Modelling*. All functions appear as underlined entries in alphabetic order. If a function depends on others, the list of dependencies appears below the underlined name. Following a standard in UNIX and R, functions whose name begins with a period (*dot functions*) are considered hidden from the user. *PBS Modelling* enforces this standard through the NAMESPACE protocol discussed above in section B.3.

.addslashes

.autoConvertMode

.buildgrid
- .createTkFont
- .createWidget

.catError

.convertMatrixListToDataFrame
- .getMatrixListSize
- .setMatrixElement

.convertMatrixListToMatrix
- .getMatrixListSize
- .setMatrixElement

.convertMode

.convertPararmStrToList
- .catError
- .trimWhiteSpace

.convertPararmStrToVector
- .catError
- .trimWhiteSpace

.convertVecToArray
- .getArrayPts
- .mapArrayToVec

.createTkFont
- .convertPararmStrToVector

.createWidget
- .isReallyNull

.createWidget.button
- .createTkFont
- .extractData

.createWidget.check
- .createTkFont
- .extractData
- .map.add

.createWidget.data
- .createWidget.grid
- .stopWidget

.createWidget.entry
- .createTkFont
- .createWidget.grid
- .extractData
- .map.add

.createWidget.grid
- .buildgrid
- .createTkFont

.createWidget.history
- .createWidget.grid
- initPBShistory

.createWidget.label
- .createTkFont

.createWidget.matrix
- .createWidget.grid
- .stopWidget

.createWidget.null

.createWidget.object
- .createWidget

.createWidget.radio
- .createTkFont
- .extractData
- .map.add

.createWidget.slide
- .createTkFont
- .extractData
- .map.add

.createWidget.slideplus
  .extractData
  .map.add
  .map.set

.createWidget.text
  .createTkFont
  .map.add

.createWidget.vector
  .createWidget.grid
  .stopWidget

.extractData
  setWinAct

.extractFuns

.extractVar
  .convertMatrixListToDataFrame
  .convertMatrixListToMatrix
  .convertMode
  .isReallyNull
  .map.getAll
  .matrixHelp
  .PBSdimnameHelper

.fibC

.fibCall

.fibClosedForm

.fibR

.getArrayPts

.getMatrixListSize
  .getMatrixListSize

.getParamFromStr
  .catError
  .convertPararmStrToList
  .isReallyNull
  .searchCollection
  .stripSlashes
  .stripSlashesVec
  .trimWhiteSpace

.inCollection

.initPBSoptions

.isReallyNull

.map.add
  .isReallyNull
  .map.init

.map.get

.map.getAll

.map.init

.map.set
  .isReallyNull
  .map.init

.mapArrayToVec

.matrixHelp
  .matrixHelp

.parsegrid
  .parsegrid

.parsemenu
  .parsemenu

.PBSdimnameHelper

.readList.P
  .catError
  .readList.P.convertData
  .stripComments
  .trimWhiteSpace

.readList.P.convertData
  .autoConvertMode
  .catError
  .convertMode
  .convertPararmStrToVector
  .convertVecToArray
  .getParamFromStr

.searchCollection

.setMatrixElement
  .setMatrixElement

.setWinValHelper
  .map.get
  .setWinValHelper

.stopWidget

.stripComments
  .stripComments

.stripSlashes
  .catError

.stripSlashesVec
  .catError

.trimWhiteSpace

.updatePBShistory
  setWinVal

.validateWindowDescList
  .validateWindowDescWidgets

.validateWindowDescWidgets

.writeList.P
  .addslashes

addArrows

addLabel

addLegend

addPBShistory
  .updatePBShistory
  getWinAct
  getWinVal

backPBShistory
  .updatePBShistory
  getWinAct
  setWinVal

calcFib
  .fibC
  .fibCall
  .fibClosedForm
  .fibR

calcGM

calcMin
  restorePar
  scalePar
  show0

clearAll

clearPBShistory
  .updatePBShistory
  getWinAct
  rmPBShistory

clearWinVal
  getWinVal

closeWin
  .isReallyNull

compileDescription
  parseWinFile
  writeList

createVector
  createWin

createWin
  .createWidget
  .initPBSoptions
  .map.init
  .validateWindowDescList
  parseWinFile

drawBars

expandGraph

exportPBShistory
  getWinAct
  promptSaveFile
  writeList

findPat

focusWin

forwPBShistory
  .updatePBShistory
  getWinAct
  setWinVal

genMatrix

getPBSext
  .isReallyNull

getPBSoptions

getWinAct

getWinFun

getWinVal
  .extractVar
  .isReallyNull

GT0

importPBShistory
  .updatePBShistory
  getWinAct
  promptOpenFile
  readList

initPBShistory

jumpPBShistory
  .updatePBShistory
  getWinAct
  getWinVal
  setWinVal

openFile
  .initPBSoptions
  .isReallyNull
  getPBSext
  getWinAct
  openFile

pad0

parseWinFile
  .getParamFromStr
  .parsegrid
  .parsemenu
  .stripComments
  .trimWhiteSpace

pause

pickCol

plotACF

plotAsp

plotBubbles

plotCsum
  addLabel
  resetGraph

plotDens

plotTrace

promptOpenFile
  .trimWhiteSpace

promptSaveFile
  promptOpenFile

readList
  .readList.P

resetGraph

restorePar

rmPBShistory
  .updatePBShistory
  getWinAct
  setWinVal

runExamples
  closeWin
  createWin
  getWinAct
  getWinVal
  setWinAct
  setWinVal

scalePar

setPBSext

setPBSoptions

setWinAct

setWinVal
  .isReallyNull
  .setWinValHelper

show0

showArgs

testCol

testLty

testLwd
  resetGraph

testPch
  resetGraph

testWidgets
  closeWin
  createWin
  getWinAct
  getWinVal
  setWinVal

unpackList

view

writeList
  .writeList.P

C.3. *PBS Modelling* manual

The following pages show the standard R manual for *PBS Modelling*, including help pages for all objects, a table of contents, and an index. This manual also appears on the CRAN web site:

http://cran.r-project.org/

Locate "Packages", find "PBSmodelling", and download the file "PBSmodelling.pdf".

To generate the pages that follow, we use the file `Rd2.tex`, mentioned in Step 9 of Appendix B.2. The first few lines must be edited to select letter (not A4) paper and start on page 65, the next page of this report. Luckily, that page number is odd, so that the next page becomes the front of a two-sided copy. In the present context, our LaTeX file begins with the lines:

```
\nonstopmode{}
\documentclass[letter]{book}
\usepackage[times,hyper]{Rd}
\usepackage{makeidx}
\makeindex{}
\begin{document}
\setcounter{page}{65}
```

where a boldface red font indicates changes to the file `Rd2.tex`. After processing this revised file with LaTeX, we obtain a PDF file that can be appended to a PDF file with the first 62 pages of this report. Readers may wish to use a similar technique with their own packages, if they decide to produce a User's Guide similar to this one.

Package 'PBSmodelling'

January 26, 2007

Version 1.06

Date 2007-01-24

Title PBS Modelling

Author Jon T. Schnute <SchnuteJ@pac.dfo-mpo.gc.ca>, Alex Couture-Beil <alex@mofo.ca>, and Rowan Haigh <HaighR@pac.dfo-mpo.gc.ca>

Maintainer Jon Schnute <SchnuteJ@pac.dfo-mpo.gc.ca>

Depends R (>= 2.3.0)

Suggests PBSmapping, odesolve, BRugs

Description PBS Modelling provides software to facilitate the design, testing, and operation of computer models. It focuses particularly on tools that make it easy to construct and edit a customized graphical user interface (GUI). Although it depends heavily on the R interface to the Tcl/Tk package, a user does not need to know Tcl/Tk. The package contains examples that illustrate models built with other R packages, including PBS Mapping, odesolve, and BRugs. It also serves as a convenient prototype for building new R packages, along with instructions and batch files to facilitate that process. The root library directory of PBSmodelling includes a complete user guide PBSmodelling-UG.pdf. To use this package effectively, please consult the guide.

License GPL version 2 or newer

R topics documented:

CCA.qbr 67
GT0 68
PBSmodelling 69
addArrows 69
addLabel 70
addLegend 71
calcFib 71
calcGM 72
calcMin 73

clearAll . . . 75
clearWinVal . . . 75
closeWin . . . 76
compileDescription . . . 76
createVector . . . 77
createWin . . . 78
drawBars . . . 79
expandGraph . . . 80
exportPBShistory . . . 80
findPat . . . 81
focusWin . . . 82
genMatrix . . . 83
getPBSext . . . 83
getPBSoptions . . . 84
getWinAct . . . 85
getWinFun . . . 85
getWinVal . . . 86
importPBShistory . . . 86
initPBShistory . . . 87
openFile . . . 89
pad0 . . . 90
parseWinFile . . . 90
pause . . . 91
pickCol . . . 92
plotACF . . . 92
plotAsp . . . 93
plotBubbles . . . 94
plotCsum . . . 95
plotDens . . . 95
plotTrace . . . 96
promptOpenFile . . . 97
promptSaveFile . . . 98
readList . . . 99
resetGraph . . . 99
restorePar . . . 100
runExamples . . . 100
scalePar . . . 101
setPBSext . . . 102
setPBSoptions . . . 102
setWinAct . . . 103
setWinVal . . . 103
show0 . . . 104
showArgs . . . 105
testCol . . . 106
testLty . . . 106
testLwd . . . 107
testPch . . . 108
testWidgets . . . 108

unpackList 110
vbdata 111
vbpars 111
view 112
writeList 112

`CCA.qbr` *Dataset: Sampled Counts of Quillback Rockfish (Sebastes maliger)*

Description

Count of sampled fish-at-age for quillback rockfish (*Sebastes maliger*) in Johnstone Strait, British Columbia, from 1984 to 2004.

Usage

```
data(CCA.qbr)
```

Format

A matrix with 70 rows (ages) and 14 columns (years). Attributes "syrs" and "cyrs" specify years of survey and commercial data, respectively.

`[,c(3:5,9,13,14)]`	Counts-at-age from research survey samples
`[,c(1,2,6:8,10:12)]`	Counts-at-age from commercial fishery samples

All elements represent sampled counts-at-age in year. Zero-value entries indicate no observations.

Details

Handline surveys for rockfish have been conducted in Johnstone Strait (British Columbia) and adjacent waterways (126°37'W to 126°53'W, 50°32'N to 50°39'N) since 1986. Yamanaka and Richards (1993) describe surveys conducted in 1986, 1987, 1988, and 1992. In 2001, the Rockfish Selective Fishery Study (Berry 2001) targeted quillback rockfish *Sebastes maliger* for experiments on improving survival after capture by hook and line gear. The resulting data subsequently have been incorporated into the survey data series. The most recent survey in 2004 essentially repeated the 1992 survey design. Fish samples from surveys have been supplemented by commercial hand-line fishery samples taken from a larger region (126°35'W to 127°39'W, 50°32'N to 50°59'N) in the years 1984-1985, 1989-1991, 1993, 1996, and 2000 (Schnute and Haigh 2007).

Note

Years 1994, 1997-1999, and 2002-2003 do not have data.

Source

Fisheries and Oceans Canada - GFBio database:
`http://www-sci.pac.dfo-mpo.gc.ca/sa-mfpd/statsamp/StatSamp_GFBio.htm`

References

Berry, M.D. 2001. Area 12 (Inside) Rockfish Selective Fishery Study. Science Council of British Columbia, Project Number FS00- 05.

Schnute, J.T., and Haigh, R. 2007. Compositional analysis of catch curve data with an application to *Sebastes maliger*. ICES Journal of Marine Science (in press).

Yamanaka, K.L. and Richards, L.J. 1993. 1992 Research catch and effort data on nearshore reef-fishes in British Columbia Statistical Area 12. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2184, 77 pp.

Examples

```
# Plot age proportions (blue bubbles = survey data, red = commercial)
data("CCA.qbr", package="PBSmodelling")
z <- CCA.qbr; cyr <- attributes(z)$cyrs;
z <- apply(z,2,function(x){x/sum(x)}); z[,cyr] <- -z[,cyr];
x <- as.numeric(dimnames(z)[[2]]); xlim <- range(x) + c(-.5,.5);
y <- as.numeric(dimnames(z)[[1]]); ylim <- range(y) + c(-1,1);
plotBubbles(z,xval=x,yval=y,powr=.5,size=0.15,lwd=1,clrs=c("blue","red"),
            xlim=xlim,ylim=ylim,xlab="Year",ylab="Age",cex.lab=1.5)
```

GT0 — *Restrict a Numeric Variable to a Positive Value*

Description

Restrict a numeric value x to a positive value using a differentiable function. GT0 stands for "greater than zero".

Usage

```
GT0(x,eps=1e-4)
```

Arguments

x	vector of values
eps	minimum value greater than zero.

Details

```
if (x >= eps).........GT0 = x
if (0 < x < eps).....GT0 = (eps/2) * (1 + (x/eps)^2)
if (x <= 0)..........GT0 = eps/2
```

Examples

```
plotGT0 <- function(eps=1,x1=-2,x2=10,n=1000,col="black") {
        x <- seq(x1,x2,len=n); y <- GT0(x,eps);
        lines(x,y,col=col,lwd=2); invisible(list(x=x,y=y)); }

testGT0 <- function(eps=c(7,5,3,1,.1),x1=-2,x2=10,n=1000) {
        x <- seq(x1,x2,len=n); y <- x;
        plot(x,y,type="l");
        mycol <- c("red","blue","green","brown","violet","orange","pink");
        for (i in 1:length(eps))
                plotGT0(eps=eps[i],x1=x1,x2=x2,n=n,col=mycol[i]);
        invisible(); };

testGT0()
```

`PBSmodelling` *PBS Modelling*

Description

PBS Modelling provides software to facilitate the design, testing, and operation of computer models. It focuses particularly on tools that make it easy to construct and edit a customized graphical user interface (GUI). Although it depends heavily on the R interface to the `Tcl/Tk` package, a user does not need to know Tcl/Tk.

`PBSmodelling` contains examples that illustrate models built uisng other R packages, including `PBSmapping`, `odesolve`, and `BRugs`. It also serves as a convenient prototype for building new R packages, along with instructions and batch files to facilitate that process.

The root library directory of `PBSmodelling` includes a complete user guide "PBSmodelling-UG.pdf". To use this package effectively, please consult the guide.

PBS Modelling comes packaged with several examples that can be accessed using the function `runExamples()`.

`addArrows` *Add Arrows to a Plot Using Relative (0:1) Coordinates*

Description

Call the `arrows` function using relative (0:1) coordinates.

Usage

```
addArrows(x1, y1, x2, y2, ...)
```

Arguments

x1	x-coordinate (0:1) at base of arrow.
y1	y-coordinate (0:1) at base of arrow.
x2	x-coordinate (0:1) at tip of arrow.
y2	y-coordinate (0:1) at tip of arrow.
...	additional paramaters for the function arrows.

Details

Lines will be drawn from (x1[i],y1[i]) to (x2[i],y2[i])

See Also

addLabel, addLegend

Examples

```
tt=seq(from=-5,to=5,by=0.01)
plot(sin(tt), cos(tt)*(1-sin(tt)), type="l")
addArrows(0.2,0.5,0.8,0.5)
addArrows(0.8,0.95,0.95,0.55, col="#FF0066")
```

---

addLabel *Add a Label to a Plot Using Relative (0:1) Coordinates*

Description

Place a label in a plot using relative (0:1) coordinates

Usage

```
addLabel(x, y, txt, ...)
```

Arguments

x	x-axis coordinate in the range (0:1); can step outside.
y	y-axis coordinate in the range (0:1); can step outside.
txt	desired label at (x, y).
...	additional arguments passed to the function text.

See Also

addArrows, addLegend

Examples

```
resetGraph()
addLabel(0.75,seq(from=0.9,to=0.1,by=-0.10),c('a','b','c'), col="#0033AA")
```

`addLegend` *Add a Legend to a Plot Using Relative (0:1) Coordinates*

Description

Place a legend in a plot using relative (0:1) coordinates.

Usage

```
addLegend(x, y, ...)
```

Arguments

`x`	x-axis coordinate in the range (0:1); can step outside.
`y`	y-axis coordinate in the range (0:1); can step outside.
`...`	arguments used by the function `legend`, such as `lines`, `text`, or `rectangle`.

See Also

`addArrows`, `addLabel`

Examples

```
resetGraph(); n <- sample(1:length(colors()),15); clrs <- colors()[n]
addLegend(.2,1,fill=clrs,leg=clrs,cex=1.5)
```

`calcFib` *Calculate Fibonacci Numbers by Several Methods*

Description

Compute Fibonacci numbers using four different methods: 1) iteratively using R code, 2) via the closed function in R code, 3) iteratively in C using the `.C` function, and 4) iteratively in C using the `.Call` function.

Usage

```
calcFib(n, len=1, method="C")
```

Arguments

`n`	nth fibonacci number to calculate
`len`	a vector of length `len` showing previous fibonacci numbers
`method`	select method to use: `C`, `Call`, `R`, `closed`

Value

Vector of the last `len` Fibonacci numbers calculated.

calcGM — *Calculate the Geometric Mean, Allowing for Zeroes*

Description

Calculate the geometric mean of a numeric vector, possibly excluding zeroes and/or adding an offset to compensate for zero values.

Usage

```
calcGM(x, offset = 0, exzero = TRUE)
```

Arguments

x	vector of numbers
offset	value to add to all components, including zeroes
exzero	if TRUE, exclude zeroes (but still add the offset)

Value

geometric mean of the modified vector `x + offset`

Note

NA values are automatically removed from x

Examples

```
calcGM(c(0,1,100))
calcGM(c(0,1,100),offset=0.01,exzero=FALSE)
```

calcMin — *Calculate the Minimum of a User-Defined Function*

Description

Minimization based on the R-stat functions `nlm`, `nlminb`, and `optim`. Model parameters are scaled and can be active or not in the minimization.

Usage

```
calcMin(pvec, func, method="nlm", trace=0, maxit=1000, reltol=1e-8,
        steptol=1e-6, temp=10, repN=0, ...)
```

Arguments

`pvec`	Initial values of the model parameters to be optimized. `pvec` is a data frame comprising four columns (`"val"`, `"min"`, `"max"`, `"active"`) and as many rows as there are model parameters. The `"active"` field (logical) determines whether the parameters are estimated (`T`) or remain fixed (`F`).
`func`	The user-defined function to be minimized (or maximized). The function should return a scalar result.
`method`	The minimization method to use: one of `nlm`, `nlminb`, `Nelder-Mead`, `BFGS`, `CG`, `L-BFGS-B`, or `SANN`. Default is `nlm`.
`trace`	Non-negative integer. If positive, tracing information on the progress of the minimization is produced. Higher values may produce more tracing information: for method `"L-BFGS-B"` there are six levels of tracing. Default is `0`.
`maxit`	The maximum number of iterations. Default is `1000`.
`reltol`	Relative convergence tolerance. The algorithm stops if it is unable to reduce the value by a factor of `reltol * (abs(val) + reltol)` at a step. Default is `1e-8`.
`steptol`	A positive scalar providing the minimum allowable relative step length. Default is `1e-6`.
`temp`	Temperature controlling the `"SANN"` method. It is the starting temperature for the cooling schedule. Default is `10`.
`repN`	Reports the parameter and objective function values on the R-console every `repN` evaluations. Default is `0` for no reporting.
`...`	Further arguments to be passed to the optimizing function chosen: `nlm`, `nlminb`, or `optim`. Beware of partial matching to earlier arguments.

Details

See `optim` for details on the following methods: `Nelder-Mead`, `BFGS`, `CG`, `L-BFGS-B`, and `SANN`.

Value

A list with components:

`Fout`	The output list from the optimizer function chosen through `method`.
`iters`	Number of iterations.
`evals`	Number of evaluations.
`cpuTime`	The user CPU time to execute the minimization.
`elapTime`	The total elapsed time to execute the minimization.
`fminS`	The objective function value calculated at the start of the minimization.
`fminE`	The objective function value calculated at the end of the minimization.
`Pstart`	Starting values for the model parameters.
`Pend`	Final values estimated for the model parameters from the minimization.
`AIC`	Akaike's Information Criterion
`message`	Convergence message from the minimization routine.

Note

Some arguments to `calcMin` have no effect depending on the `method` chosen.

See Also

`nlm`, `nlminb`, and `optim` in R's `stats` package.

Examples

```
Ufun <- function(P) {
        Linf <- P[1]; K <- P[2]; t0 <- P[3]; obs <- afile$len;
        pred <- Linf * (1 - exp(-K*(afile$age-t0)));
        n <- length(obs); ssq <- sum((obs-pred)^2 );
        return(n*log(ssq)); };
afile <- data.frame(age=1:16,len=c(7.36,14.3,21.8,27.6,31.5,35.3,39,
        41.1,43.8,45.1,47.4,48.9,50.1,51.7,51.7,54.1));
pvec <- data.frame(val=c(70,0.5,0),min=c(40,0.01,-2),max=c(100,2,2),
        active=c(TRUE,TRUE,TRUE),row.names=c("Linf","K","t0"),
        stringsAsFactors=FALSE);
alist <- calcMin(pvec=pvec,func=Ufun,method="nlm",steptol=1e-4,repN=10);
print(alist[-1]); P <- alist$Pend;
resetGraph(); expandGraph();
xnew <- seq(afile$age[1],afile$age[nrow(afile)],len=100);
ynew <- P[1] * (1 - exp(-P[2]*(xnew-P[3])) );
plot(afile); lines(xnew,ynew,col="red",lwd=2);
addLabel(.05,.88,paste(paste(c("Linf","K","t0"),round(P,c(2,4,4)),
        sep=" = "),collapse="\n"),adj=0,cex=0.9);
```

`clearAll` — *Remove all R Objects From the Global Environment*

Description

Generic function to clear .RData in R

Usage

```
clearAll(hidden=TRUE, verbose=TRUE)
```

Arguments

`hidden`	if `TRUE`, remove variables that start with a dot (.)
`verbose`	if `TRUE`, report all removed items

`clearWinVal` *Remove all Current Widget Variables*

Description

Remove all global variables that share a name in common with any widget variable name defined in `names(getWinVal())`. Use this function with caution.

Usage

```
clearWinVal()
```

See Also

`getWinVal`

`closeWin` *Close GUI Window(s)*

Description

Close (destroy) one or more windows made with `createWin`.

Usage

```
closeWin(name)
```

Arguments

`name`	a vector of window names that indicate which windows to close. These names appear in the Window Description File(s) on the line(s) defining WINDOW widgets. If `name` is ommitted, all active windows will be closed.

See Also

`createWin`

compileDescription *Convert and Save a Window Description as a List*

Description

Convert a Window Description File (ASCII markup file) to an equivalent Window Description List. The output list (an ASCII file containing R-source code) is complete, i.e., all default values have been added.

Usage

```
compileDescription(descFile, outFile)
```

Arguments

descFile	file name of markup file.
outFile	file name of output file containing R source code.

Details

The Window Description File `descFile` is converted to a list, which is then converted to R code, and saved to `outFile`.

See Also

`parseWinFile`, `createWin`

createVector *Create a GUI with a Vector Widget*

Description

Create a basic window containing a vector and a submit button. This provides a quick way to create a window without the need for a Window Description File.

Usage

```
createVector(vec, vectorLabels=NULL, func="",
             windowname="vectorwindow")
```

Arguments

vec	a vector of strings representing widget variables. The values in vec become the default values for the widget. If vec is named, the names are used as the variable names.
vectorLabels	an optional vector of strings to use as labels above each widget.
func	string name of function to call when new data are entered in widget boxes or when "GO" is pressed.
windowname	unique window name, required if multiple vector windows are created.

See Also

createWin

Examples

```
## Not run:
#user defined function which is called on new data
drawLiss <- function() {
  getWinVal(scope="L");
  tt <- 2*pi*(0:k)/k; x <- sin(2*pi*m*tt); y <- sin(2*pi*(n*tt+phi));
  plot(x,y,type="p"); invisible(NULL); };

#create the vector window
createVector(c(m=2, n=3, phi=0, k=1000),
  vectorLabels=c("x cycles","y cycles", "y phase", "points"),
  func="drawLiss");
## End(Not run)
```

---

createWin *Create a GUI Window*

Description

Create a GUI window with widgets using instructions from a Window Description (markup) File.

Usage

```
createWin(fname, astext=FALSE)
```

Arguments

fname	file name of Window Description File or list returned from parseWinFile.
astext	logical; if TRUE, interpret fname as a vector of strings with each element representing a line in a Window Description File.

Details

Generally, the markup file contains a single widget per line. However, widgets can span multiple lines by including a backslash ('\') character at the end of a line, prompting the suppression of the newline character.

For more details on widget types and markup file, see "PBSModelling-UG.pdf" in the installation directory.

It is possible to use a Window Description List produced by `compileDescription` rather than a file name for `fname`.

Another alternative is to pass a vector of characters to `fname` and set `astext=T`. This vector represents the file contents where each element is equivalent to a new line in the Window Description File.

Note

Microsoft Windows users may experience difficulties switching focus between the R console and GUI windows. The latter frequently disappear from the screen and need to be reselected (either clicking on the task bar or pressing <Alt><Tab>. This issue can be resolved by switching from MDI to SDI mode. From the R console menu bar, select <Edit> and <GUI preferences>, then change the value of "single or multiple windows" to SDI.

See Also

`parseWinFile`, `getWinVal`, `setWinVal`

`closeWin`, `compileDescription`, `createVector`

`initPBShistory` for an example of using `astext=TRUE`

Examples

```
## Not run:
#see file testWidgets\LissWin.txt in PBSmodelling package directory

# Calculate and draw the Lissajous figure
drawLiss <- function() {
        getWinVal(scope="L");
        ti <- 2*pi*(0:k)/k; x <- sin(2*pi*m*ti); y <- sin(2*pi*(n*ti+phi));
        plot(x,y,type=ptype); invisible(NULL); };

createWin(system.file("testWidgets/LissWin.txt",package="PBSmodelling"));
## End(Not run)
```

---

drawBars — *Draw a Linear Barplot on the Current Plot*

Description

Draw a linear barplot on the current plot.

Usage

```
drawBars(x, y, width, base = 0, ...)
```

Arguments

`x`	x-coordinates
`y`	y-coordinates
`width`	bar width, computed if missing
`base`	y-value of the base of each bar
`...`	further graphical parameters (see `par`) may also be supplied as arguments

Examples

```
plot(0:10,0:10,type="n")
drawBars(x=1:9,y=9:1,col="deepskyblue4",lwd=3)
```

`expandGraph` *Expand the Plot Area by Adjusting Margins*

Description

Optimize the plotting region(s) by minimizing margins.

Usage

```
expandGraph(mar=c(4,3,1.2,0.5), mgp=c(1.6,.5,0),...)
```

Arguments

`mar`	numerical vector of the form 'c(bottom, left, top, right)' specifying the margins of the plot
`mgp`	numerical vector of the form 'c(axis title, axis labels, axis line)' specifying the margins for axis title, axis labels, and axis line
`...`	additional graphical parameters to be passed to `par`

See Also

`resetGraph`

Examples

```
resetGraph(); expandGraph(mfrow=c(2,1));
tt=seq(from=-10, to=10, by=0.05);

plot(tt,sin(tt), xlab="this is the x label",  ylab="this is the y label",
       main="main title", sub="sometimes there is a \"sub\" title")
plot(cos(tt),sin(tt*2), xlab="cos(t)", ylab="sin(2 t)", main="main title",
       sub="sometimes there is a \"sub\" title")
```

exportPBShistory *Export a Saved History*

Description

Export the current history list.

Usage

```
exportPBShistory(hisname="", fname="")
```

Arguments

hisname	name of the history list to export. If set to "", the value from getWinAct()[1] will be used instead.
fname	file name where history will be saved. If it is set to "", a **Save As** window will be displayed.

See Also

importPBShistory, initPBShistory, promptSaveFile

findPat *Search a Character Vector to Find Multiple Patterns*

Description

Use all available patterns in pat to search in vec, and return the matched elements in vec.

Usage

```
findPat(pat, vec)
```

Arguments

pat	character vector of patterns to match in vec
vec	character vector where matches are sought

Value

A character vector of all matched strings.

Examples

```
#find all strings with a vowel, or that start with a number
findPat(c("[aeoiy]", "^[0-9]"), c("hello", "WRLD", "11b"))
```

`focusWin` *Set the Focus on a Particular Window*

Description

Bring the specified window into focus, and set it as the active window. `focusWin` will fail to bring the window into focus if it is called from the R console, since the R console returns focus to itself once a function returns. However, it will work if `focusWin` is called as a result of calling a function from the GUI window. (i.e., pushing a button or any other widget that has a function argument).

Usage

```
focusWin(winName, winVal=TRUE)
```

Arguments

`winName`	name of window to focus
`winVal`	if `TRUE`, associate `winName` with the default window for `setWinVal` and `getWinVal`

Examples

```
## Not run:
focus <- function() {
  winName <- getWinVal()$select;
  focusWin(winName);
  cat("calling focusWin(\"", winName, "\")\n", sep="");
  cat("getWinVal()$myvar = ", getWinVal()$myvar, "\n\n", sep=""); };

#create three windows named win1, win2, win3
#each having three radio buttons, which are used to change the focus
for(i in 1:3) {
  winDesc <- c(
    paste('window name=win',i,' title="Win',i,'"', sep=''),
    paste('entry myvar ', i, sep=''),
    'radio name=select value=win1 text="one" function=focus mode=character',
    'radio name=select value=win2 text="two" function=focus mode=character',
    'radio name=select value=win3 text="three" function=focus mode=character');
  createWin(winDesc, astext=TRUE); };
## End(Not run)
```

`genMatrix` *Generate Test Matrices for plotBubbles*

Description

Generate a test matrix of random numbers (`mu` = mean and `signa` = standard deviation), primarily for `plotBubbles`.

Usage

```
genMatrix(m,n,mu=0,sigma=1)
```

Arguments

`m`	number of rows
`n`	number of columns
`mu`	mean of normal distribution
`sigma`	standard deviation of normal distribution

Value

An `m` by `n` matrix with normally distributed random values.

See Also

`plotBubbles`

Examples

```
plotBubbles(genMatrix(20,6))
```

`getPBSext` *Get a Command Associated With a Filename*

Description

Display all locally defined file extensions and their associated commands, or search for the command associated with a specific file extension `ext`.

Usage

```
getPBSext(ext)
```

Arguments

`ext`	optional string specifying a file extension (suffix)

Value

Command associated with file extension.

Note

These file associations are not saved from one *PBS Modelling* session to the next.

See Also

`setPBSext`, `openFile`

`getPBSoptions` *Retreive A User Option*

Description

Get a previously defined user option.

Usage

```
getPBSoptions(option)
```

Arguments

`option`	name of option to retrieve. If omitted, a list containing all options is returned.

Value

Value of the specified option, or `NULL` if the specified option is not found.

See Also

`getPBSext`

`getWinAct` *Retreive the Last Window Action*

Description

Get a string vector of actions (latest to earliest).

Usage

```
getWinAct(winName)
```

Arguments

`winName`	name of window to retrieve action from

Details

When a function is called from a GUI, a string descriptor associated with the action of the function is stored internaly (appended to the first position of the action vector). A user can utilize this action as a type of argument for programming purposes. The command `getWinAct()[1]` yields the latest action.

Value

String vector of recorded actions (latest first).

`getWinFun` *Retrieve Names of Functions Referenced in a Window*

Description

Get a vector of all function names referenced by a window.

Usage

```
getWinFun(winName)
```

Arguments

`winName`	name of window, to retrieve its function list

Value

A vector of function names referenced by a window.

`getWinVal` *Retreive Widget Values for Use in R Code*

Description

Get a list of variables defined and set by the GUI widgets. An optional argument `scope` directs the function to create local or global variables based on the list that is returned.

Usage

```
getWinVal(v=NULL, scope="", asvector=FALSE, winName="")
```

Arguments

`v`	vector of variable names to retrieve from the GUI widgets. If `NULL`, `v` retrieves all variables from all GUI widgets.
`scope`	scope of the retrieval. The default sets no variables in the non-GUI environment; `scope="L"` creates variables locally in relation to the parent frame that called the function; and `scope="G"` creates global variables(`pos=1`).
`asvector`	return a vector instead of a list. WARNING: if a widget variable defines a true vector or matrix, this will not work.
`winName`	window from which to select GUI widget values. The default takes the window that has most recently received new user input.

Value

A list (or vector) with named components, where names and values are defined by GUI widgets.

See Also

`parseWinFile`, `setWinVal`, `clearWinVal`

`importPBShistory` *Import a History List from a File*

Description

Import a history list from file `fname`, and place it into the history list `hisname`.

Usage

```
importPBShistory(hisname="", fname="")
```

Arguments

`hisname`	name of the history list to be populated. The default (`""`) uses the value from `getWinAct()[1]`.
`fname`	file name of history file to import. The default (`""`) causes an open-file window to be displayed.

See Also

`exportPBShistory`, `initPBShistory`, `promptOpenFile`

`initPBShistory` *Create Structures of a New History Widget*

Description

PBS history functions (below) are available to those who would like to use the package's history functionality, without using the pre-defined history widget. These functions allow users to create customized history widgets.

Usage

```
initPBShistory(hisname, indexname=NULL, sizename=NULL, overwrite=TRUE)
rmPBShistory(hisname="", index="")
addPBShistory(hisname="")
forwPBShistory(hisname="")
backPBShistory(hisname="")
jumpPBShistory(hisname="", index="")
clearPBShistory(hisname="")
```

Arguments

`hisname`	name of the history "list" to manipulate. If it is omitted, the function uses the value of `getWinAct()[1]` as the history name. This allows the calling of functions directly from the Window Description File (except `initPBShistory`, which must be called before `createWin()`).
`indexname`	name of the index entry widget in the Window Description File. If `NULL`, then the current index feature will be disabled.
`sizename`	name of the current size entry widget. If `NULL`, then the current size feature will be disabled.
`index`	index to the history item. The default (`""`) causes the value to be extracted from the widget identified by `indexname`.
`overwrite`	if `TRUE`, history (matching `hisname`) will be cleared. Otherwise, the imported history will be merged with the current one.

Details

PBS Modelling includes a pre-built history widget designed to collect interesting choices of GUI variables so that they can be redisplayed later, rather like a slide show.

Normally, a user would invoke a history widget simply by including a reference to it in the Window Description File. However, PBS Modelling includes support functions (above) for customized applications.

To create a customized history, each button must be described separately in the Window Description File rather than making reference to the history widget.

The history "List" must be initialized before any other functions may be called. The use of a unique history name (`hisname`) is used to associate a unique history session with the supporting functions.

The `indexname` and `sizename` arguments correspond to the given names of entry widgets in the Window Description File, which will be used to display the current index and total size of the list. The `indexname` entry widget can also be used by `jumpPBShistory` to retrieve a target index.

See Also

`importPBShistory`, `exportPBShistory`

Examples

```
## Not run:
# Example of creating a custom history widget that saves values
# whenever the "Plot" button is pressed. The user can tweak the
# inputs "a", "b", and "points" before each "Plot" and see the
# "Index" increase. After sufficient archiving, the user can review
# scenarios using the "Back" and "Next" buttons.
# A custom history is needed to achieve this functionality since
# the packages pre-defined history widget does not update plots.

# To start, create a Window Description to be used with createWin
# using astext=TRUE. P.S. Watch out for special characters which
# must be "escaped" twice (first for R, then PBSmodelling).

winDesc <- '
        window title="Custom History"
        vector names="a b k" labels="a b points" font="bold" \\
        values="1 1 1000" function=myPlot
        grid 1 3
                button function=myHistoryBack text="<- Back"
                button function=myPlot text="Plot"
                button function=myHistoryForw text="Next ->"
        grid 2 2
                label "Index"
                entry name="myHistoryIndex" width=5
                label "Size"
                entry name="myHistorySize" width=5
'
# Convert text to vector with each line represented as a new element
```

```
winDesc <- strsplit(winDesc, "\n")[[1]]

# Custom functions to update plots after restoring history values
myHistoryBack <- function() {
        backPBShistory("myHistory");
        myPlot(saveVal=FALSE); # show the plot with saved values
}
myHistoryForw <- function() {
        forwPBShistory("myHistory");
        myPlot(saveVal=FALSE); # show the plot with saved values
}
myPlot <- function(saveVal=TRUE) {
        # save all data whenever plot is called (directly)
        if (saveVal) addPBShistory("myHistory");
        getWinVal(scope="L");
        tt <- 2*pi*(0:k)/k;
        x <- (1+sin(a*tt));  y <- cos(tt)*(1+sin(b*tt));
        plot(x, y);
}

initPBShistory("myHistory", "myHistoryIndex", "myHistorySize")
createWin(winDesc, astext=TRUE)
## End(Not run)
```

`openFile` *Open a File with the Associated Program*

Description

Open a file using the program associated with its extension defined by the Windows shell. Non-windows users, or users wishing to overide the default application, can specify a program association using `setPBSext`.

Usage

```
openFile(fname)
```

Arguments

`fname`	file name of file to open.

Note

If a command is registered with `setPBSext`, then `openFile` will replace all occurrences of `"%f"` with the absolute path of the filename, before executing the command.

See Also

`getPBSext`, `setPBSext`, `shell.exec`

Examples

```
## Not run:
# Set up firefox to open .html files
setPBSext("html", '"c:/Program Files/Mozilla Firefox/firefox.exe" file://%f')
openFile("foo.html")
## End(Not run)
```

`pad0` *Pad Numbers with Leading Zeroes*

Description

Convert numbers to integers then text, and pad them with leading zeroes.

Usage

```
pad0(x, n, f = 0)
```

Arguments

`x`	vector of numbers
`n`	number of text characters representing a padded integer
`f`	factor of 10 transformation on x before padding

Value

A character vector representing x with leading zeroes.

Examples

```
resetGraph(); x <- pad0(x=123,n=10,f=0:7);
addLabel(.5,.5,paste(x,collapse="\n"),cex=1.5);
```

`parseWinFile` *Convert a Window Description File into a List Object*

Description

Parse a Window Description (markup) File into the list format expected by `createWin()`.

Usage

```
parseWinFile(fname, astext=FALSE)
```

Arguments

fname	file name of the Window Description File.
astext	if TRUE, fname is interpreted as a vector of strings, with each element representing a line of code in a Window Description File.

Value

A list representing a parsed Window Description File that can be directly passed to createWin.

Note

All widgets are forced into a 1-column by N-row grid.

See Also

createWin, compileDescription

Examples

```
## Not run:
x<-parseWinFile(system.file("examples/LissFigWin.txt",package="PBSmodelling"))
createWin(x)
## End(Not run)
```

---

pause *Pause Between Graphics Displays or Other Calculations*

Description

Pause, typically between graphics displays. Useful for demo purposes.

Usage

```
pause(s = "Press <Enter> to continue")
```

Arguments

s	text issued on the command line when pause is invoked.

`pickCol` *Pick a Colour From a Palette and get the Hexadecimal Code*

Description

Display an interactive colour palette from which the user can choose a colour.

Usage

```
pickCol(returnValue=TRUE)
```

Arguments

`returnValue`	If `TRUE`, display the full colour palette, choose a colour, and return the hex value to the R session. If `FALSE`, use an intermediate GUI to interact with the palette and display the hex value of the chosen colour.

Value

A hexidecimal colour value.

See Also

`testCol`

Examples

```
## Not run:
junk<-pickCol(); resetGraph(); addLabel(.5,.5,junk,cex=4,col=junk);
## End(Not run)
```

`plotACF` *Plot Autocorrelation Bars From a data frame, matrix, or vector*

Description

Plot autocorrelation bars (ACF) from a data frame, matrix, or vector.

Usage

```
plotACF(file, lags=20,
        clrs=c("blue","red","green","magenta","navy"), ...)
```

Arguments

`file`	data frame, matrix, or vector of numeric values.
`lags`	maximum number of lags to use in the ACF calculation.
`clrs`	vector of colours. Patterns are repeated if the number of fields exceeed the length of `clrs`.
`...`	additional arguments for `plot` or `lines`.

Details

This function is designed primarily to give greater flexibility when viewing results from the R-package `BRugs`. Use `plotACF` in conjuction with `samplesHistory("*",beg=0,plot=FALSE)` rather than `samplesAutoC` which calls `plotAutoC`.

Examples

```
resetGraph(); plotACF(trees,lwd=2,lags=30);
```

`plotAsp` — *Construct a Plot with a Specified Aspect Ratio*

Description

Plot `x` and `y` coordinates using a specified aspect ratio.

Usage

```
plotAsp(x, y, asp=1, ...)
```

Arguments

`x`	vector of x-coordinate points in the plot.
`y`	vector of y-coordinate points in the plot.
`asp`	y/x aspect ratio.
`...`	additional arguments for `plot`.

Details

The function `plotAsp` differs from `plot(x,y,asp=1)` in the way axis limits are handled. Rather than expand the range, `plotAsp` expands the margins through padding to keep the aspect ratio accurate.

Examples

```
x <- seq(0,10,0.1)
y <- sin(x)
par(mfrow=2:1)
plotAsp(x,y,asp=1,xlim=c(0,10),ylim=c(-2,2), main="sin(x)")
plotAsp(x,y^2,asp=1,xlim=c(0,10),ylim=c(-2,2), main="sin^2(x)")
```

`plotBubbles` *Construct a Bubble Plot from a Matrix*

Description

Construct a bubble plot for a matrix `z`.

Usage

```
plotBubbles(z, xval = FALSE, yval = FALSE, rpro = FALSE,
   cpro = FALSE, rres = FALSE, cres = FALSE, powr = 1,
   clrs = c("black", "red"), size = 0.2, lwd = 2, debug = FALSE, ...)
```

Arguments

`z`	input matrix
`xval`	x-values for the columns of `z`. if `xval=TRUE`, the first row contains x-values for the columns.
`yval`	y-values for the rows of `z`. If `yval=TRUE`, the first column contains y-values for the rows.
`rpro`	logical; if `TRUE`, convert rows to proportions.
`cpro`	logical; if `TRUE`, convert columns to proportions.
`rres`	logical; if `TRUE`, use row residuals (subtract row means).
`cres`	logical; if `TRUE`, use column residuals (subtract column means).
`powr`	power transform. Radii are proportional to `z^powr`. Note: `powr=0.5` yields bubble areas proportional to `z`.
`clrs`	colours (2-element vector) used for positive and negative values.
`size`	size (inches) of the largest bubble.
`lwd`	line width for drawing circles.
`debug`	logical; if `TRUE`, display debug information.
`...`	additional arguments for `symbols` function.

See Also

`genMatrix`

Examples

```
plotBubbles(genMatrix(20,6),clrs=c("green","red"));
```

plotCsum *Plot Cumulative Sum of Data*

Description

Plot the cumulative frequency of a data vector or matrix, showing the median and mean of the distribution.

Usage

```
plotCsum(x, add = FALSE, ylim = c(0, 1), xlab = "Measure",
ylab = "Cumulative Proportion", ...)
```

Arguments

x	vector or matrix of numeric values.
add	logical; if TRUE, add the cumulative frequency curve to a current plot.
ylim	limits for the y-axis.
xlab	label for the x-axis.
ylab	label for the y-axis.
...	additional arguments for the plot function.

Examples

```
x <- rgamma(n=1000,shape=2)
plotCsum(x)
```

plotDens *Plot Density Curves from a data frame, matrix, or vector*

Description

Plot the density curves from a data frame, matrix, or vector. The mean density curve of the data combined is also shown.

Usage

```
plotDens(file, clrs=c("blue","red","green","magenta","navy"), ...)
```

Arguments

file	data frame, matrix, or vector of numeric values.
clrs	vector of colours. Patterns are repeated if the number of fields exceeed the length of clrs.
...	additional arguments for plot or lines.

Details

This function is designed primarily to give greater flexibility when viewing results from the R-package `BRugs`. Use `plotDens` in conjuction with `samplesHistory("*",beg=0,plot=FALSE)` rather than `samplesDensity` which calls `plotDensity`.

Examples

```
z <- data.frame(y1=rnorm(50,sd=2),y2=rnorm(50,sd=1),y3=rnorm(50,sd=.5))
plotDens(z,lwd=3)
```

`plotTrace` — *Plot Trace Lines from a data frame, matrix, or vector*

Description

Plot trace lines from a data frame or matrix where the first field contains x-values, and subsequent fields give y-values to be traced over x. If input is a vector, this is traced over the number of observations.

Usage

```
plotTrace(file, clrs=c("blue","red","green","magenta","navy"), ...)
```

Arguments

`file`	data frame or matrix of x and y-values, or a vector of y-values.
`clrs`	vector of colours. Patterns are repeated if the number of traces (y-fields) exceeed the length of `clrs`.
`...`	additional arguments for `plot` or `lines`.

Details

This function is designed primarily to give greater flexibility when viewing results from the R-package `BRugs`. Use `plotTrace` in conjuction with `samplesHistory("*",beg=0,plot=FALSE)` rather than `samplesHistory` which calls `plotHistory`.

Examples

```
z <- data.frame(x=1:50,y1=rnorm(50,sd=3),y2=rnorm(50,sd=1),y3=rnorm(50,sd=.25))
plotTrace(z,lwd=3)
```

`promptOpenFile` *Display an "Open File" Dialogue*

Description

Display the default **Open** prompt provided by the Operating System.

Usage

```
promptOpenFile(initialfile="", filetype=list(c("*","All Files")),
               open=TRUE)
```

Arguments

`initialfile`	file name of the text file containing the list.
`filetype`	a list of character vectors indicating file types made available to users of the GUI. Each vector is of length one or two. The first element specifies either the file extension or `"*"` for all file types. The second element gives an optional descriptor name for the file type. The supplied `filetype` list appears as a set of choices in the pull-down box labelled "Files of type:"".
`open`	logical; if `TRUE` display **Open** prompt, if `FALSE` display **Save As** prompt.

Value

The file name and path of the file selected by the user.

See Also

`promptSaveFile`

Examples

```
## Not run:
# Open a filename, and return it line by line in a vector
scan(promptOpenFile(),what=character(),sep="\n")

# Illustrates how to set filetype.
promptOpenFile("intial_file.txt", filetype=list(c(".txt", "text files"),
               c(".r", "R files"), c("*", "All Files")))
## End(Not run)
```

`promptSaveFile` *Display a "Save File" Dialogue*

Description

Display the default **Save As** prompt provided by the Operating System.

Usage

```
promptSaveFile(initialfile="", filetype=list(c("*", "All Files")),
               save=TRUE)
```

Arguments

`initialfile`	file name of the text file containing the list.
`filetype`	a list of character vectors indicating file types made available to users of the GUI. Each vector is of length one or two. The first element specifies either the file extension or `"*"` for all file types. The second element gives an optional descriptor name for the file type. The supplied `filetype` list appears as a set of choices in the pull-down box labelled "Files of type:".
`save`	logical; if `TRUE` display **Save As** prompt, if `FALSE` display **Open** prompt.

Value

The file name and path of the file selected by the user.

See Also

`promptOpenFile`

Examples

```
## Not run:
#illustrates how to set filetype.
promptSaveFile("intial_file.txt", filetype=list(c(".txt", "text files"),
             c(".r", "R files"), c("*", "All Files")))
## End(Not run)
```

`readList` *Read a List from a File in PBS Modelling Format*

Description

Read in a list previously saved to a file by `writeList`. At present, only two formats are supported - R's native format used by the `dput` function or an ad hoc `PBSmodelling` format. The function `readList` detects the format automatically.

For information about the `PBSmodelling` format, see `writeList`.

Usage

```
readList(fname)
```

Arguments

`fname`	file name of the text file containing the list.

See Also

`writeList`, `unpackList`

`resetGraph` *Reset par Values for a Plot*

Description

Reset `par()` to default values to ensure that a new plot utilizes a full figure region. This function helps manage the device surface, especially after previous plotting has altered it.

Usage

```
resetGraph()
```

See Also

`resetGraph`

`restorePar` *Get Actual Parameters from Scaled Values*

Description

Restore scaled parameters to their original units. Used in minimization by `calcMin`.

Usage

```
restorePar(S,pvec)
```

Arguments

`S`	scaled parameter vector.
`pvec`	a data frame comprising four columns - `c("val","min","max","active")` and as many rows as there are model parameters. The `"active"` field (logical) determines whether the parameters are estimated (`TRUE`) or remain fixed (`FALSE`).

Details

Restoration algorithm: $P = P_{min} + (P_{max} - P_{min})(sin(\frac{\pi S}{2}))^2$

Value

Parameter vector converted from scaled units to original units specified by `pvec`.

Examples

```
pvec <- data.frame(val=c(1,100,10000),min=c(0,0,0),max=c(5,500,50000),
        active=c(TRUE,TRUE,TRUE))
S    <- c(.5,.5,.5)
P    <- restorePar(S,pvec)
print(cbind(pvec,S,P))
```

`runExamples` *Run GUI Examples Included with PBS Modelling*

Description

Display an interactive GUI to demonstrate PBS Modelling examples.

The example source files can be found in the directory `PBSmodelling/examples`, located in R's directory `library`.

Usage

```
runExamples()
```

Details

Some examples use external packages which must be installed to work correctly:

`BRugs` - `LinReg`, `MarkRec`, and `CCA`;

`odesolve` - `FishRes`;

`PBSmapping` - `FishTows`.

Note

The examples are copied from `PBSmodelling/examples` to R's current temporary working directory and run from there.

`scalePar` *Scale Parameters to [0,1]*

Description

Scale parameters for function minimization by `calcMin`.

Usage

```
scalePar(pvec)
```

Arguments

`pvec`	a data frame comprising four columns - `c("val","min","max","active")` and as many rows as there are model parameters. The `"active"` field (logical) determines whether the parameters are estimated (`TRUE`) or remain fixed (`FALSE`).

Details

Scaling algorithm: $S = \frac{2}{\pi} asin \sqrt{\frac{P - P_{min}}{P_{max} - P_{min}}}$

Value

Parameter vector scaled between 0 and 1.

Examples

```
pvec <- data.frame(val=c(1,100,10000),min=c(0,0,0),max=c(5,500,50000),
        active=c(TRUE,TRUE,TRUE))
S    <- scalePar(pvec)
print(cbind(pvec,S))
```

`setPBSext` *Set a Command Associated with a Filename Extension*

Description

Set a command with an associated extension (suffix), for use in `openFile`. The command must specify where the target file name is inserted by indicating a `%f`.

Usage

```
setPBSext(ext, cmd)
```

Arguments

`ext`	string of specifying the extension suffix.
`cmd`	command string to associate with the extension.

Note

These values are not saved from one PBS Modelling session to the next.

See Also

`getPBSext`, `openFile`

`setPBSoptions` *Set A User Option*

Description

Some options may be set by the user.

Usage

```
setPBSoptions(option, value)
```

Arguments

`option`	name of the option to set.
`value`	new value to assign this option.

See Also

`getPBSoptions`

`setWinAct` *Add a Window Action to the Saved Action Vector*

Description

Append a string value specifying an action to the first position of an action vector.

Usage

```
setWinAct(winName, action)
```

Arguments

`winName`	window name where action is taking place.
`action`	string value describing an action.

Details

When a function is called from a GUI, a string descriptor associated with the action of the function is stored internaly (appended to the first position of the action vector). A user can utilize this action as a type of argument for programming purposes. The command `getWinAct()[1]` yields the latest action.

Sometimes it is useful to "fake" an action. Calling `setWinAct` allows the recording of an action, even if a button has not been pressed.

`setWinVal` *Update Widget Values*

Description

Update a widget with a new value.

Usage

```
setWinVal(vars, winName)
```

Arguments

`vars`	a list or vector with named components.
`winName`	window from which to select GUI widget values. The default takes the window that has most recently received new user input.

Details

The `vars` argument expects a list or vector with named elements. Every element name corresponds to the widget name which will be updated with the supplied element value.

The `vector`, `matrix`, and `data` widgets can be updated in several ways. If more than one name is specified for the `names` argument of these widgets, each element is treated like an `entry` widget.

If however, a single `name` describes any of these three widgets, the entire widget can be updated by passing an appropriately sized object.

Alternatively, any element can be updated by appending its index in square brackets to the end of the `name`. The `data` widget is indexed differently than the `matrix` widget by adding "d" after the brackets. This tweak is necessary for the internal coding (bookkeeping) of PBS Modelling. Example: `"foo[1,1]d"`.

See Also

`getWinVal`, `createWin`

Examples

```
## Not run:
winDesc <- c("vector length=3 name=vec",
             "matrix nrow=2 ncol=2 name=mat",
             "slideplus name=foo");
createWin(winDesc, astext=TRUE)
setWinVal(list(vec=1:3, "mat[1,1]"=123, foo.max=1.5, foo.min=0.25, foo=0.7))
## End(Not run)
```

---

show0 — *Convert Numbers into Text with Specified Decimal Places*

Description

Return a character representation of a number with added zeroes out to a specified number of decimal places.

Usage

```
show0(x, n, add2int = FALSE)
```

Arguments

`x`	numeric data (scalar, vector, or matrix).
`n`	number of decimal places to show, including zeroes.
`add2int`	If `TRUE`, add zeroes on the end of integers.

Value

A scalar/vector of strings representing numbers. Useful for labelling purposes.

Note

This function does not round or truncate numbers. It simply adds zeroes if `n` is greater than the available digits in the decimal part of a number.

Examples

```
frame()

#do not show decimals on integers
addLabel(0.25,0.75,show0(15.2,4))
addLabel(0.25,0.7,show0(15.1,4))
addLabel(0.25,0.65,show0(15,4))

#show decimals on integers
addLabel(0.25,0.55,show0(15.2,4,TRUE))
addLabel(0.25,0.5,show0(15.1,4,TRUE))
addLabel(0.25,0.45,show0(15,4,TRUE))
```

`showArgs` *Display Expected Widget Arguments*

Description

Display the order and default values of **all** widget arguments. The list can be shortened by specifying a single widget name.

Usage

```
showArgs(widget="")
```

Arguments

`widget`	If specified, information about this one widget only is displayed. The default displays information about all widgets.

Value

A text stream to the R console. Cannot be directed to a file or other device.

`testCol` *Display Named Colours Available Based on a Set of Strings*

Description

Display colours as patches in a plot. Useful for programming purposes. Colours can be specified in any of 3 different ways: (i) by colour name, (ii) by hexidecimal colour code created by `rgb()`, or (iii) by an index to the `color()` palette.

Usage

```
testCol(cnam=colors()[sample(length(colors()),15)])
```

Arguments

`cnam`	vector of colour names to display. Defaults to 15 random names from the `color` palette.

See Also

`pickCol`

Examples

```
testCol(c("sky","fire","sea","wood"))

testCol(c("plum","tomato","olive","peach","honeydew"))

testCol(substring(rainbow(63),1,7))

#display all colours set in the colour palette
testCol(1:length(palette()))

#they can even be mixed
testCol(c("#9e7ad3", "purple", 6))
```

`testLty` *Display Line Types Available*

Description

Display line types available.

Usage

```
testLty(newframe = TRUE)
```

Arguments

`newframe`	if `TRUE`, create a new blank frame, otherwise overlay current frame.

Note

Quick representation of first 20 line types for reference purposes.

`testLwd` *Display Line Widths*

Description

Display line widths. User can specify particular ranges for `lwd`. Colours can also be specified and are internally repeated as necessary.

Usage

```
testLwd(lwd=1:20, col=c("black","blue"), newframe=TRUE)
```

Arguments

`lwd`	line widths to display. Ranges can be specified.
`col`	colours to use for lines. Patterns are repeated if `length(lwd) > length(col)`
`newframe`	if `TRUE`, create a new blank frame, otherwise overlay current frame.

Examples

```
testLwd(3:15,col=c("salmon","aquamarine","gold"))
```

`testPch` *Display Plotting Symbols and Backslash Characters*

Description

Display plotting symbols. User can specify particular ranges (increasing continuous integer) for `pch`.

Usage

```
testPch(pch=1:100, ncol=10, grid=TRUE, newframe=TRUE, bs=FALSE)
```

Arguments

`pch`	symbol codes to view.
`ncol`	number of columns in display (can only be 2, 5, or 10). Most sensibly this is set to 10.
`grid`	logical; if `TRUE`, grid lines are plotted for visual aid.
`newframe`	logical; if `TRUE` reset the graph, otherwise overlay on top of the current graph.
`bs`	logical; if `TRUE`, show backslash characters used in text statements (e.g., `30\272C` = 30°C).

Examples

```
testPch(123:255)
testPch(1:25,ncol=5)
testPch(41:277,bs=TRUE)
```

`testWidgets` *Displays Sample GUIs and their Source Code*

Description

Display an interactive GUI to demonstrate the available widgets in PBS Modelling. A `text` window displays the Window Description File source code. The user can modify this sample code and recreate the test GUI by pressing the button below.

The Window Description Files can be found in the directory `PBSmodelling/testWidgets` located in the R directory `library`.

Usage

```
testWidgets()
```

Details

Following are the widgets and default values supported by PBS Modelling. See Appendix A in "PBSModelling-UG.pdf" for detailed descriptions.

```
button text="Calculate" font="" fg="black" bg="" width=0
function="" action="button" sticky="" padx=0 pady=0

check name mode=logical checked=FALSE text="" font="" fg="black" bg=""
function="" action="check" sticky="" padx=0 pady=0

data nrow ncol names modes="numeric" rowlabels="" collabels=""
rownames="X" colnames="Y" font="" fg="black" bg="" entryfont=""
entryfg="black" entrybg="white" values="" byrow=TRUE function=""
enter=TRUE action="data" width=6 sticky="" padx=0 pady=0
```

```
entry name value="" width=20 label="" font="" fg="" bg=""
entryfont="" entryfg="black" entrybg="white" function=""
enter=TRUE action="entry" mode="numeric" sticky="" padx=0 pady=0

grid nrow=1 ncol=1 toptitle="" sidetitle="" topfont="" sidefont=""
byrow=TRUE borderwidth=1 relief="flat" sticky="" padx=0 pady=0

history name="default" archive=TRUE sticky="" padx=0 pady=0

label text="" font="" fg="black" bg="" sticky="" padx=0 pady=0

matrix nrow ncol names rowlabels="" collabels="" rownames=""
colnames="" font="" fg="black" bg="" entryfont="" entryfg="black"
entrybg="white" values="" byrow=TRUE function="" enter=TRUE
action="matrix" mode="numeric" width=6 sticky="" padx=0 pady=0

menu nitems=1 label font=""

menuitem label font="" function action="menuitem"

null padx=0 pady=0

object name font="" fg="black" bg="" entryfont=""
entryfg="black" entrybg="white" vertical=FALSE function=""
enter=TRUE action="data" width=6 sticky="" padx=0 pady=0

radio name value text="" font="" fg="black" bg="" function=""
action="radio" mode="numeric" sticky="" padx=0 pady=0

slide name from=0 to=100 value=NA showvalue=FALSE
orientation="horizontal" font="" fg="black" bg="" function=""
action="slide" sticky="" padx=0 pady=0

slideplus name from=0 to=1 by=0.01 value=NA function=""
enter=FALSE action="slideplus" sticky="" padx=0 pady=0

text name height=8 width=30 edit=FALSE fg="black" bg="white"
mode="character" font="" value="" borderwidth=1 relief="sunken"
padx=0 pady=0

vector names length=0 labels="" values="" vecnames="" font=""
fg="black" bg="" entryfont="" entryfg="black" entrybg="white"
vertical=FALSE function="" enter=TRUE action="vector"
mode="numeric" width=6 sticky="" padx=0 pady=0

window name="window" title="" vertical=TRUE bg="#D4D0C8"
fg="#000000" onclose=""
```

See Also

`createWin`, `showArgs`

`unpackList` *Unpack List Elements into Variables*

Description

Make local or global variables (depending on the scope specified) from the named components of a list.

Usage

```
unpackList(x, scope="L")
```

Arguments

`x`	named list to unpack.
`scope`	If `"L"`, create variables local to the parent frame that called the function. If `"G"`, create global variables.

Value

A character vector of unpacked variable names.

See Also

`readList`

Examples

```
x <- list(a=21,b=23);
unpackList(x);
print(a);
```

`vbdata` *Dataset: Length-at-Age Data for a von Bertalanffy Curve*

Description

Lengths-at-age for freshwater mussels (*Anodonta kennerlyi*).

Usage

```
data(vbdata)
```

Format

A data frame with 16 rows and 2 columns `c("age","len")`.

Details

Data for demonstartion of the von Bertalanffy model used in the `calcMin` example.

Source

Mittertreiner, A., and Schnute, J. 1985. Simplex: a manual and software package for easy nonlinear parameter estimation and interpretation in fishery research. Canadian Technical Report of Fisheries and Aquatic Sciences 1384: xi + 90 p.

`vbpars` *Dataset: Initial Parameters for a von Bertalanffy Curve*

Description

Starting parameter values for `Linf`, `K`, and `t0` for von Bertalanffy minimization using length-at-age data (`vbdata`) for freshwater mussels (*Anodonta kennerlyi*).

Usage

```
data(vbpars)
```

Format

A matrix with 3 rows and 3 columns `c("Linf","K","t0")`. Each row contains the starting values, minima, and maxima, respectively, for the three parameters.

Details

Data for demonstration of the von Bertalanffy model used in the `calcMin` example.

Source

Mittertreiner, A., and Schnute, J. 1985. Simplex: a manual and software package for easy nonlinear parameter estimation and interpretation in fishery research. Canadian Technical Report of Fisheries and Aquatic Sciences 1384: xi + 90 p.

`view` *Display First n Rows of an Object*

Description

View the first `n` rows of a data frame or matrix or the first `n` elements of a vector or list. All other objects are simply reflected.

Usage

```
view(obj, n = 5)
```

Arguments

`obj`	object to view.
`n`	first `n` rows (matrix/data frame) or elements (vector/list) of `obj` to view.

`writeList` *Write a List to a File in PBS Modelling Format*

Description

Write an ASCII text representation in either `"D"` format or `"P"` format. The `"D"` format makes use of `dput` and `dget`, and produces an R representation of the list. The `"P"` format represents a simple list in an easy-to-read, ad hoc `PBSmodelling` format.

Usage

```
writeList(x, fname, format="D", comments="")
```

Arguments

`x`	R list object to write to an ASCII text file.
`fname`	file name of the text file containing the list.
`format`	format of the file to create: `"D"` or `"P"`.
`comments`	vector of character strings to use as initial-line comments in the file.

Details

The `"D"` format is equivalent to using R's `base` functions `dput` and `dget`, which support all R objects.

The `"P"` format only supports named lists of vectors, matrices, and data frames. Scalars are treated like vectors. Nested lists are not supported.

The `"P"` format writes each named element in a list using the following conventions: (i) $ followed by the name of the data object to denote the start of that object's description; (ii) $$ on the next line to describe the object's structure - object type, mode(s), names (if vector), rownames (if matrix or data), and colnames (if matrix or data); and (iii) subsequent lines of data (one line for vector, multiple lines for matrix or data).

Multiple rows of data for matrices or data frames must have equal numbers of entries (separated by whitespace).

For complete details, see "PBSmodelling-UG.pdf" in R's directory `library/PBSmodelling`.

See Also

`readList`, `openFile`

Examples

```
## Not run:
test <- list(a=10,b=euro,c=view(WorldPhones),d=view(USArrests))
writeList(test,"test.txt",format="P",
        comments=" Scalar, Vector, Matrix, Data Frame")
openFile("test.txt")
## End(Not run)
```

Index

*Topic **arith**
calcFib, 71
calcGM, 72
*Topic **array**
genMatrix, 83
*Topic **color**
pickCol, 92
testCol, 106
testLty, 106
testLwd, 107
testPch, 108
*Topic **datasets**
CCA.qbr, 67
vbdata, 111
vbpars, 111
*Topic **device**
expandGraph, 80
resetGraph, 99
*Topic **file**
openFile, 89
readList, 99
unpackList, 110
writeList, 112
*Topic **graphs**
plotACF, 92
plotDens, 95
plotTrace, 96
*Topic **hplot**
drawBars, 79
GT0, 68
plotAsp, 93
plotBubbles, 94
plotCsum, 95
*Topic **iplot**
addArrows, 69
addLabel, 70
addLegend, 71
*Topic **list**
readList, 99
unpackList, 110
writeList, 112
*Topic **methods**
clearAll, 75
clearWinVal, 75
focusWin, 82
getPBSext, 83
getPBSoptions, 84
getWinAct, 85
getWinFun, 85
getWinVal, 86
setPBSext, 102
setPBSoptions, 102
setWinAct, 103
setWinVal, 103
*Topic **misc**
exportPBShistory, 80
importPBShistory, 86
parseWinFile, 90
pause, 91
promptOpenFile, 97
promptSaveFile, 98
*Topic **nonlinear**
calcMin, 73
*Topic **optimize**
calcMin, 73
restorePar, 100
scalePar, 101
*Topic **package**
PBSmodelling, 69
*Topic **print**
pad0, 90
show0, 104
view, 112
*Topic **utilities**
closeWin, 76
compileDescription, 76
createVector, 77
createWin, 78

findPat, 81
initPBShistory, 87
runExamples, 100
showArgs, 105
testCol, 106
testLty, 106
testLwd, 107
testPch, 108
testWidgets, 108

addArrows, 69, *70*, *71*
addLabel, 70, *70*, *71*
addLegend, *70*, 71
addPBShistory *(initPBShistory)*, 87

backPBShistory *(initPBShistory)*, 87

calcFib, 71
calcGM, 72
calcMin, 73
CCA.qbr, 67
clearAll, 75
clearPBShistory *(initPBShistory)*, 87
clearWinVal, 75, *86*
closeWin, 76, *78*
compileDescription, 76, *78*, *91*
createVector, 77, *78*
createWin, *76*, *77*, 78, *91*, *104*, *110*

drawBars, 79

expandGraph, 80
exportPBShistory, 80, *87*, *88*

findPat, 81
focusWin, 82
forwPBShistory *(initPBShistory)*, 87

genMatrix, 83, *94*
getPBSext, 83, *84*, *89*, *102*
getPBSoptions, 84, *102*
getWinAct, 85
getWinFun, 85
getWinVal, *75*, *78*, 86, *104*
GTO, 68

importPBShistory, *81*, 86, *88*
initPBShistory, *78*, *81*, 87, *87*

jumpPBShistory *(initPBShistory)*, 87

openFile, *84*, 89, *102*, *113*

padO, 90
parseWinFile, *77*, *78*, *86*, 90
pause, 91
PBSmodelling, 69
PBSmodelling-package *(PBSmodelling)*, 69
pickCol, 92, *106*
plotACF, 92
plotAsp, 93
plotBubbles, *83*, 94
plotCsum, 95
plotDens, 95
plotTrace, 96
promptOpenFile, *87*, 97, *98*
promptSaveFile, *81*, 97, 98

readList, 99, *110*, *113*
resetGraph, *80*, 99, *99*
restorePar, 100
rmPBShistory *(initPBShistory)*, 87
runExamples, 100

scalePar, 101
setPBSext, *84*, *89*, 102
setPBSoptions, 102
setWinAct, 103
setWinVal, *78*, *86*, 103
shell.exec, *89*
showO, 104
showArgs, 105, *110*

testCol, *92*, 106
testLty, 106
testLwd, 107
testPch, 108
testWidgets, 108

unpackList, *99*, 110

vbdata, 111, *111*
vbpars, 111
view, 112

widgets *(testWidgets)*, 108
writeList, *99*, 112